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PHYSICS AND POLITICS[1]

AN OLD ANALOGY REVISED

IT is just fifty-five years since Walter Bagehot wrote his "Physics and Politics," a very suggestive book in its day. He began the first chapter of this book with a reference to "the sudden acquisition of much physical knowledge" which had marked the second half of the nineteenth century, and declared it his purpose to show the bearing of these new ideas upon the political conceptions of mankind. That purpose he fulfilled with much ingenuity, pointing out the various lines along which the advance in natural science seemed to suggest modifications in the old theories of the state and government.

This was only a half-century ago; yet the new physics of Bagehot's day has already grown old. Its basic concepts have been turned inside out and upside down. Its laws relating to the indestructibility of mass and the conservation of energy have been radically amended. Even a generation ago the atom was held to be the ultimate and indivisible unit in the composition of the universe. It was the basis upon which the scientists of the nineteenth century built up an inclusive set of laws and principles relating to the structure of all creation.

To-day, all this is changed. The world is still composed of atoms; but we have discovered that they are not the last word in matter. On the contrary, they are themselves incessantly in process of division into still smaller, highly-energized particles known as electrons. These diminutive units of disembodied electricity, as they may be called, are continually in flight, yet they form part of every atom in the universe. It is quite possible, and even probable, that these electrons are engaged in the business of transforming matter into energy, and energy into matter. If this be so, there is nothing solid in the old sense, nothing static, nothing that is not continually in process of change.

Nor is this all. In Bagehot's day the science of physics was mainly concerned with visible and large-scale phenomena, with such mechanics of nature as were observable to the naked eye. To-day the physicist has shifted most of his attention to the study of

[1] Presidential address delivered at the twenty-fourth annual meeting of the American Political Science Association, Washington, D. C., December 29, 1927.

small-scale and invisible things. The gross appearances no longer mean much to him. The general acceptance of the quantum theory has wrought a revolution in all the exact sciences. Even the chief corner-stone of the old physics, the law of gravitation, has been jolted out of place. Bagehot wrote in an age when scientists looked upon gravity as a force; to-day we are assured that it is merely one of the properties of space. And space itself is a concern of relativity, hence there is no such thing as absolute position or absolute movement. All things in the physical universe are relative to all things else.

It has been said that no metaphysical implications are necessarily involved in the quantum theory or in the doctrine of relativity, but it is difficult to believe that this can be the case. A revolution so amazing in our ideas concerning the structure of the universe must inevitably carry its echoes into all fields of human knowledge. New truths can not be quarantined. No branch of knowledge advances by itself. In its program it draws others along. By no jugglery of words can we keep mind and matter and motion in water-tight compartments, hence it is inconceivable that a greatly changed point of view, or a series of far-reaching discoveries in any one science can be wholly without influence upon the others, even upon those which are not closely allied. Science begins by altering the day's routine and ends by transferring our orientation towards the social cosmos.

The acceptance of the doctrine of evolution (to take an illustration from the past) did not confine its effects to biology, or even to the natural sciences as a whole. It compelled a general recasting of the older ideas concerning the origin of the state and of government; it threw political science into a new dependence upon history, and led Sir James Seeley to declare in one of his famous epigrams that history without political science could have no fruition. It impelled the student of politics to look upon public institutions as part of the whole evolving order of things, like the protoplasmic cell and the living organism.

And so the "sudden acquisition of much physical knowledge" which has marked the first quarter of the twentieth century would seem to suggest the timeliness of examining once again the old foundations of political sciences upon which we have built up our theories concerning the citizen's relation to his government. Natural science has moved a long way, not only from the teachings of Galileo and Newton, but even from those of Helmholtz and Kelvin; yet political science is still dallying fondly with the abstract formalism of Locke and Montesquieu, Austin, Blackstone and Bentham. It is still concerning itself with theories of absolute rights and duties, with old axioms about sovereignty and the general will, the sanction of law, the rule of public opinion, and the mass behaviorism of free and equal men and women who are assumed to be the ultimate atoms of sovereignty in the commonwealth.

It is still in bondage to eighteenth-century deification of the abstract individual man. Both the science and the art of government still rest upon what may be called the atomic theory of politics—upon the postulate that all able-bodied citizens are of equal weight, volume, and value; endowed with various absolute and unalienable rights; vested with equally absolute duties; and clothed with the attribute of an indivisible sovereignty. Under the influence of ideas which were borrowed from the old natural philosophy we continue to assume that the science of government can be a science only if it is based upon a series of fixed uniformities. Our vernacular and our thinking are still heavily saturated with the idea that there are laws and principles of human liberty to which all government must conform. And these principles we have embodied in a series of impostor axioms which stultify the free thought of the people and form the greatest of all obstacles to the orderly progress of social control.

So long as the social order was simple, without the unending complexities that have been infused into it during the past half century, these older formulas were not beyond the power of rational minds to accept—just as the old concepts of natural science were able to pass muster in the days when laboratory experiments were simple and few. But although we have now passed into an age when the vast laboratory of world politics is conducting experiments of every kind with unmeasurable rapidity, we continue the attempt to explain *our* electrodynamics in terms of mechanics—an attempt which the physicists abandoned a generation ago.

II

The American philosophy of government has exalted the individual citizen beyond all reason. It treats him as the incarnation of the Unknown Soldier. This is partly the result of our legacy from Puritanism, and in part the outcome of a pioneer insistence upon free scope for individualism. Hence it is the national habit to think of social control and individual freedom in terms of hostility to each other, whereas it is only through the one that the other can be realized. For even as every molecule of physical matter is conditioned and directed by those with which it interacts, so the individual citizen is similarly motivated and controlled by the influence of those with whom he associates. These influences, moreover, are not radiated upon him most strongly by society as a

whole; they come from within his own orbit of life. They come directly from the immediate environment—his race, his religion, his political party, his labor union, his club, his newspaper and all the rest. He is the creature of his group-application. These influences are so penetrating, indeed, that for most of our citizenship the dogma of individual freedom is hardly more than a myth. Hence the first problem of political science is not that of adjusting social control to the interests of the individual citizen, but of securing and maintaining a fair balance between the various groups to which the individuals belong.

In other words it is time for political science to step up into line with the new physics by turning some of its attention to the sub-atomic possibilities. We should seek to discover the true reasons for that vast differentiation between good, bad and indifferent citizenship, which is perhaps the most obvious of all the phenomena of politics. We should enquire diligently into the nature and scope of the forces which make each civic atom what he is. And we should discard our allegiance to the absolute, for nothing would seem to be more truly self-evident than the proposition that all civic rights and duties, all forms and methods of government, indeed all principles of political science, are relative to one another, as well as to time and place and circumstance. They can not be stated compressed into rigid formulas.

III

Both in the physical world and in the body politic the atoms have this in common, that they are neither ultimate nor indivisible. The individual citizen, when you pull him apart, is a nucleus of heredity. He is the creature of a habit-system. But the whole training imposed upon us by civilization is based upon the assumption that human beings can be constrained or induced to modify their natural responses. More particularly they respond to the stimulus of ideas, the electrons of the social universe, and indeed our entire process of civic education—in the schools and colleges, by the press and at the forum—consists in bombarding the human nucleus with ideas. Some get attached, but the vast majority do not. The social atmosphere, like the physical universe, is filled with these invisible units of energy, moving at all rates of speed and penetrating power, gaining lodgment here and there, or departing from some human atom where they have been week-end guests. In the last analysis the weight of the individual citizen in the body politic is dependent upon the degree of his receptivity to these rays of intellectual illumination; it is proportioned to the number and quality of the ideas that he assimilates and retains. It is this variableness of response to the stimulus of ideas that largely accounts for the diversity among citizens in relation to their government.

Hence we have the hydrogen citizen. In his journey through the seven ages of man he manages to capture only one electron. His primal instincts have become modified by some single controlling obsession. Militant reformers, in any field, are drawn for the most part from among men and women who belong in this category. The same is true of the diehards at the other extreme, the reactionaries and the partisans of the hundred per cent. variety. They are what the physicist would call "stripped atoms." Neither of these elements ever contributes much to the orderly progress of government as an art or as a science. To continue the metaphor, it is the precious metals of mankind, not the light gases, that give both stability and movement to the social order. Even as the physical world is a composite of matter and energy, which are no longer regarded as separable, so the world of political opinion is to be looked upon as a composite of numbers and intensity, a product arising from the continuous redistribution of both. To the extent that energy is a substitute for mass, so the intelligence and the intensity with which convictions are held by a minority may offset a considerable deficiency in numerical strength.

Therein lies the flaw in such expressions as "the will of the majority" which suggests a purely quantitative measurement. The means by which a majority comes to be a majority is a matter of far greater importance than the mere existence of a majority as such. The actions and attitudes of the individual in politics become what they are by reason of the influences to which he is exposed, and more particularly the immediate influences, for the effectiveness with which a political idea or ideal can be transmitted is in part dependent upon the proximity of its source. The physicist is not content to know that the electron flies. He insists on knowing whence it cometh, whither it goeth, and to what purpose. The world is ruled by ideas which possess the power of penetration and lodgment. The electorate is merely the channel through which they become operative. Government is not, fundamentally, either an affair of laws or of men, but of imponderables behind both of them. To these imponderables, which constitute the invisible government, we have given far too little of our attention; yet we must do it if political science is to maintain an intimate contact with the realities.

IV

How, then, can the sub-atomic forces which make for the improvement of citizenship be singled out, strengthened and made more effective to the desired end? At present we have only a hazy notion of what

they are and only in a crude way do we know how they operate. All around us gigantic campaigns of civic education are being carried on, by organizations of every kind, every bit of it inspired by the hope of improving the attitude of the citizen towards his government, and especially his sense of civic duty. A large part of this effort is based upon the naïve assumption that if you only exhort people with sufficient earnestness they can be induced to accept irrational ideas embalmed in the rhetoric of patriotism. No part of this nation-wide campaign for the promotion of better citizenship utilizes a technique that has ever been examined by scientific methods to discover whether it is at all adapted to the end in view. To a considerable extent the money that is being spent upon these so-called campaigns of civic education represents pure futility and waste. The ardent efforts of well-meaning men and women are frustrated by their sheer irrelevance to the end desired. Perhaps the most striking illustration of this has been afforded in recent years by expensive campaigns for improving the quality of our elective officials by the simple device of bawling at the voter to come out and vote. It is small wonder that these campaigns are accomplishing nothing, for they rest upon formulas concerning civic duty which are not merely unscientific but ridiculous.

Political science, to become a science, should first of all obtain a decree of divorce from the philosophers, the lawyers and the psychologists with whom it has long been in the status of a polygamous companionate marriage to the detriment of its own quest for truth. The philosopher, when he can not account for a phenomenon in any other way, ascribes it to some occult quality in the moral nature of man. The psychologist, in a like quandary, seeks the explanation by going through his inventory of standardized human traits, although it ought to be clear that political behaviorism can not be even described, much less accounted for, by the study of the individual in isolation. An increase in one knowledge of human behavior results at once in a modification of human behavior, hence it is rather optimistic to hope that social psychology will ever point us the way of explaining, much less controlling the actions of men in the body politic. The laws of science are not statistics which nature obeys, and the laws of political science, if ever such laws are formed, will not be rules which human nature obeys. They will be merely definitions which explain how men in groups respond to the stimulus of ideas. It is by the methods of science, not psychology, that we can hope to discover such laws. The essentials of the scientific method are accurate observation, careful experiment, and cautious inference. The earmarks of social psychology, thus far, have been crude generalizations and fantastic claims. Still it is only fair to say, on behalf of psychology, that it has taken the first step on the way to become a real science; it has already succeeded in providing itself with a technical jargon which is incomprehensible to the ordinary man. It has managed to translate many self-evident commonplaces into foggy language.

V

Government, as Emerson once said, is "the greatest science and service of mankind." Yet the science of government has been probably the least successful of all the sciences in building up a set of principles upon which any body of men can agree. Far from having the certitude and authority of physics or chemistry, it has not yet caught up with meteorology, which some people look upon as the least exact of all the natural sciences. As a result of this backwardness in what may be called the pure science of politics there has been almost no applied science of government worthy of the name. Government as an art has been so little perfected that as respects most of the serious problems encountered by the public authorities there has been no alternative but to rely on the promptings of political intuition.

The results are plainly visible in the great and ever-widening gap which separates government and technology. By the application of science to industry, transportation, communication and construction we have made unexampled progress during the past fifty years. But whether the world has made any progress at all during this half century, in the art of governing its people is a question that many of those best qualified to speak would answer in the negative. Our rulership over nature has become more commanding year by year; but man's rulership of man has made no such advance. The wheels of government have multiplied, and they are revolving at an increased speed; yet the electorate's control of them is certainly not firmer than it used to be. Surely there is an element of danger in a situation where our progress runs so fast in all the applied sciences except the one that ought to be the greatest. For although science may be the basis of civilization, government is the retaining wall that holds the entire structure in place. Science is producing wealth but there can be no such thing as wealth save under the protection of government.

Every new application of science to industry makes life more complex, and hence government more difficult, for the difficulties of efficient government in a democracy increase as the square of the newly-created

human relations. That is why the big industrial city is so much harder to govern than is the rural area of equal population. The leaning tower of Pisa is deemed to be one of the greatest wonders of the world, yet it is an infinitely less complicated affair than an urban metropolis like Chicago in which one can find at this very moment, side by side, much of the best industrial technique and some of the worst municipal government on earth.

To be safe, our progress in the art of government ought to go faster than the advance of applied science, but unhappily it is doing nothing of the kind. It is steadily dropping behind. If the fathers of the Republic were to return to life, after their long sleep of a century, they would be equally appalled by the stupendous progress of the American people in all material things and by the relative lack of it in the art of government. Would they perceive any marked improvement in the way the laws are made, or the revenues raised, or the taxes spent? Would they note a conspicuous betterment in the caliber of the men elected to public office? Would they find our current political discussions above, or below, the plane represented by the letters in *The Federalist*? To ask these questions is to answer them.

Our immediate goal, therefore, should be to release political science from the old metaphysical and juristic concepts upon which it has traditionally been based; likewise to keep it clear of the sociologists and social psychologists who, if they could have their way, would only get us deeper into the morass of meaningless terminology. It is to the natural sciences that we may most profitably turn, in this hour of transition, for suggestions as to the reconstruction of our postulate and methods.

Political science should borrow from the new physics a determination to get rid of intellectual insincerities concerning the nature of sovereignty, the general will, natural rights and the freedom of the individual, the consent of the governed, majority rule, home rule, the rule of public opinion, state rights, laissez-faire, checks and balances, the equality of men and nations, and a government of laws. In place of these formulas it should seek to find concepts that will stand the test of actual operations, and upon them it should begin to rebuild itself by an intimate observation of the actualities.

By analogy from the new physics, moreover, it may well turn part of its attention from the large-scale and visible mechanism of politics to the invisible and hitherto much-neglected forces by which the individual citizen is fundamentally actuated and controlled. Three-quarters of a century ago the new biology suggested to us the abandonment of old ideas concerning the spontaneous creation of government; to-day the new physics may well suggest the discarding of our atomic theory of ultimate, equal and sovereign citizens in a free state. It is doubtless true that the natural scientist, as such, can never guide us to the true purposes and policies which should direct human action in matters of government; but it is equally true that only by paralleling his objectivity of attitude and his process of operational study can the political scientist ever hope to reach that goal.

WILLIAM BENNETT MUNRO

A LAYMAN'S VIEW OF HISTORY[1]

SOME time ago I received a pleasant letter from an honored officer of our Association. Among other things he said that his friends and colleagues would be glad to have one more book from me telling how it was that I came to write history. He added friendly words as to the interest of professional teachers of history in the thoughts of laymen like myself. So I am moved to give you a layman's view of history.

The muster-roll of laymen who have written histories is not a mean one. The old world offers us Herodotus, Thucydides, Xenophon, Polybius, Tacitus, no one of whom held a chair at any university. In modern times, in England, we pass from Gibbon down to Grote, and, in our own country, from Parkman to Rhodes. For myself, hovering, as I faintly hope, somewhere on the fringe of this rather Olympian company, I will endeavor to answer in a few words the query in the very friendly letter.

When I was a young man I became bent on devoting my mind and energies to the best things I could find. Not having original and creative gifts, I set myself to the study of what other men had deemed best, and had striven to attain in thought and work and conduct. I had ardently studied law, had practiced a very little, and had written a book on *Private Corporations*. But the law seemed too narrow—very far from covering the whole human field; and I turned to look beyond it. Being inclined toward the humanities rather than the sciences, I soon saw that I at least should find the most humanly interesting elements in the aim and the endeavor—the forming an ideal, and the struggle through the man's years, or perhaps through the longer life of a people, to accomplish it. The accomplishment itself, if indeed it is severable from the endeavor, might be beyond the strength either of individual or of race. Achievement lies on the knees of the gods. The true human story is a story of endeavor—the endeavor for the end conceived.

So I began with the ancient world, which is the pit

[1] Presidential address delivered before the American Historical Association at Washington, December 28, 1927.

whence we have been digged. And I devoted the ten years that were my supreme education to writing *Ancient Ideals*. That brought my notion of the story down to the time of Christianity. I gave all my time to the book, working eight hours a day, and traveling to see some of the things and countries I was studying. I had very little money, but I used it, and at last sweated blood to pay for the publication of my work.

Then, with the advantage of this discipline of knowledge, I devoted four years to *The Classical Heritage of the Middle Ages*. During two of them, I held a lectureship at Columbia, but gave it up as interfering with my real work. Profiting by this further time of studying and training, I next put ten enthusiastic years on *The Mediaeval Mind*, and, after that, six or seven years on *Thought and Expression in the Sixteenth Century*. There have been two or three smaller books, *Freedom of the Mind in History*, taking three years; and one that is now in the press bringing me to the present time.

Curiously enough I find that through all these books, if I have not been implicitly saying the same thing, I have, without intending it, been speaking with the voice of my first conviction as to the central human interest of the endeavor and the aim. Forty years, and all my mind and energy, have been put upon these books, which I mention to show the time they have taken. Such as they are, I could not have written them had my time been taken by teaching or academic administration. So much for this layman, now for his view of history.

Our ideas to-day of things about us are neither particular nor static. Rather we conceive a ceaseless movement to pervade the world; and we imagine that a like unbroken movement has brought all things to the present state of heterogeneous correlation as parts of a prodigiously variegated whole. Apparently it is one and the same universal movement that extends throughout our present world and reaches back through time. Within its sweep, past and present become a continuum, and our contemporary happenings are drawn into some real or conceptual unity. We recognize one vibrant current constituting an energizing and effective process. Each event is harnessed to the other, and the present emerges from the past. All seems an organic and possibly intelligent becoming. Perhaps this becoming is manifested most concretely in plants and animals. They *are* their past: phylogenetically as the present form of a somehow evolving species, and ontogenetically, since each living individual carries its line of ancestry to be handed on. These notions are not wholly new, yet they work in us to-day with new meaning.

If we turn from this universal process to our experience or knowledge of its phenomena, we find a like absence of barriers and separation. Fences are down between the fields of knowledge, which have become one vast *un*enclosure. Save for convenience of designation and prosecution, the sciences are no longer distinct and separate, but phases of each other, while philosophy would enfold them all in its consideration. Not unallied with them are philology, archeology, all scholarship if you will. Indeed, knowledge would conceivably become one, were there a mind genial enough to grasp it in its entirety.

Every element of our knowledge of the present world of man and nature is necessarily connected with our knowledge of that past through which man and the world he lives in have come to be what they are. We need make no distinction between our knowledge of living animals and contemporary human institutions and our knowledge of their antecedent stages. Every political or legal institution has come into existence gradually, or has arisen by notable mutation. The laws regulating corporations are of divers origin, yet there is continuity between the present body of corporation law and its multifarious past; and there need be no division in our knowledge of the past and present of this legal Briareus.

The continuity, or even oneness, between past and present is evident in the forms or provinces of knowledge. The science of physiology, for example, is a gradual and beautiful growth; its present state implies and includes its past, just as the animal organs, whose functions it treats of, contain their past genetically. Physics, so called, is also an emergence from its past, but more apparently by the way of mutation. Its fundamental conceptions appear to have suffered reversal. Yet if the old solidities of matter have been replaced by nimble units of electric energy, still the group of principles applying to the action of tangible bodies are as valid as they have ever been, and carry over the bulk of the science in its continuity. A more concrete illustration of mutation accompanying continuity is the manner in which relativity has, for a time at least, been grafted upon Newtonian gravitation.

And philosophy, that elastic method of ultimate consideration, of thinking any and all problems of the mind out to their final conclusions or despairs—this method or tissue of ultimate thinking assuredly becomes its whole self only in the oneness of its present with its past.

Yet changes come, and each age has its intellectual tendencies. Scientific or philosophic conceptions of the world are, of course, part of the thinking, even the temper, of a period. In modern physics the concepts of relativity and the substitution of electricity and motion for stolid matter are expressions of the spirit, the dynamic restlessness, of our times. So is

our science of psychology, not to mention psychoanalysis specifically. A future age, with another temperament and mentality, may not be satisfied with them.

Knowledge is experience. But not all experience is knowledge, since experience may come in the guise of feeling or intuition. Such experience is direct, and is not apprehended through cognition and statement. Indeed much of our experience is rather untranslatable into knowledge or rational statement. Experience of the past, however, commonly takes the form of knowledge, or of doubt or conscious ignorance—the two latter being a mode of cognition or failure to know. Yet contemplation of a past event may stir our feeling and, as it were, arouse an intuitive sense of its import. To that extent our experience of the past might not take the form of knowledge.

In philosophy, realists and idealists still dispute as to the relation of all forms of experience to the assumed external world—the world past and present, I would add. Whatever be this relation, the point I wish to make is that our knowledge of the past and our knowledge of the present bear a like relation to the data or objects of their respective worlds. Knowledge of the past is the same sort of absorption or mirror of events as knowledge of the present. And if in any way knowledge of the present world should be held to reach practical identity with the assumed objective data, so one might hold as to knowledge of the past.

Again, as each man's knowledge, or other experience, of the present differs from that of his fellows, so will his knowledge of the past. This is strikingly true of historians living in different ages. Each age, with its own interests and view of life, will find in the past a different range of facts and interests. To different succeeding ages the past will appear, and even *be*, different.

As touching the intellectual identity in us of past and present, we should distinguish between evident forms of knowledge, like the sciences, and the material, for example, of past politics and war. The scholar may identify his knowledge of philosophy with philosophy's past as well as present, but will pause before identifying the Battle of Waterloo with his knowledge of it. In this respect, I should group religion and the fine arts of expression with philosophy and the sciences. For they also are an intrinsic part of the growth of the human spirit, of its feeling, its intuition; part, indeed, of the whole nature of man. To be sure, the whole nature of man, including reason, may exercise itself in battles. But in them there is more physical fact and violence than in the growth of poetry and painting, or the sweeter modes of religion.

With such rather crude distinctions in mind, I introduce the word "history." As applied to modes of human growth—science, philosophy, religion, and art—I regard their history as identical with the stages of their past, which is projecting itself into the present. This is one of the two current meanings of the term. For "history" is taken sometimes as descriptive narrative and sometimes as the subject-matter itself in its evolving course and processes. Both senses of the word exist, whatever be the topic. Thus the "history" of the earth may be either the narrative called geology, or may be the very changes which geology is attempting to describe. And a "history" of mankind may be the narrative, or, on the other hand, the very actual series of poignant human facts which follow on throughout the ages. In this sense the history of mankind would be mankind itself coming gradually to its present state; or the history of institutions would be the institutions themselves in the course of their growth; and, of course, the history of art or science would be art or science in its checkered course.

Clearly enough, if history, taken as narrative, is to be a thing of life and truth it must embody the verity, or veritable history, of the past; that is, must keep itself vitally one with the unfolding subject-matter which it is presenting. And it should absorb and re-express the elements of power moving the drama of mankind.

But a narrative composition is itself an event. It is part of the substance of its age, part of the intellectual conditions (which are actualities) of the time of its composition. The mind of Thucydides and the history which he wrote were elements of the period of the Peloponnesian War. So the sardonic Roman temper of Tacitus and the histories he composed were part of his epoch. Obviously contemporary documents and state papers are part of the event which they record. But Gibbon's *Decline and Fall* was one of the events of the eighteenth century, and part of the linkage between that century's consciousness of itself and understanding of the past. We may speak in the same way of Mommsen's very Prussian *History of Rome*.

More brilliant examples of things which are events and also narratives are the works of imaginative literature and the figurative arts. They too are records and also profoundly part of the substance of events. The *Iliad* or the *Divina Commedia* is a concrete manifestation, a supreme expression, of the qualities of an epoch. On the other hand, if these poems are not what are called historical narratives, they are records and masses of evidence. So the Parthenon, or Chartres Cathedral, is a document, a piece of evidence, even a vehicle of narrative. But each of these temples is also a concrete and monumen-

tal embodiment of the skill, the resources and capacities, and the intellectual and spiritual qualities of an epoch.

So the works of Plato and Aquinas are demonstrative evidence of the Greek and medieval minds. They are also part of the substance of their respective epochs just as truly as the Battle of Plataea or the Babylonian captivity of the Holy See.

For the purpose of this address, I am taking "history" in the more vital sense of the very life and actuality of the past, out of which the present has arisen. And the two points which I have endeavored to bring out are, first, the oneness between the present and the past, and, secondly, the view of "history" as this very living past and present which, as narrative, it seeks to bring to a descriptive statement.

There is a further point of view which seems proper for us. We are historians and scholars and I would say humanists, rather than physicists, mathematicians, or biologists. Whatever may be the view of our brethren the scientists, man is for us historians the centre of the world. We regard the sciences humanistically, as manifestations of the human mind and a phase of its growth. We are not investigators of the substantial data of the sciences, nor judges of their hypothetical accuracy or possible falsity as descriptions of the world. We are concerned with science as one of the modes of advance of human thought. And we bear in mind that physical science, and each branch of it, is a unity and a whole, made of its present and its past; so that the history of any science is verily that science itself in its entirety and continuous course from its beginning to what it is now and hereafter shall come to be.

We take similar interest in philosophy, that method and mass of ultimate consideration of fact or verity. We would regard it in its totality, which is its unity, and consists in an age-long and necessary mode of thought.

Many of us believe that religion is from God; but for us as historians it is another mode of the flowering of the human spirit, yet rather in the way of intuition and immediate conviction than by the gray path of reason. For us the past and present of religion, in all its manifestations, is one, even as philosophy is one. And we would make and keep our history of religion a true expression of its manifold growth and being.

In the same way we would work as historians of those glories of the mind which come to us in the forms of poetry and imaginative prose, and in the forms of the visual arts. And similarly would we view all human institutions, social, political, and belligerent—for man is a warring animal. We consider them in their time-unity, and, in studying them, should hold their past as one with their latest manifestations. So we weave into their growing web the salient events—battles, dynastic changes, executions, famines, and noisy revolutions, through which they have wound their course.

If we seek a further and universal unification of our conceptions of these manifold courses of human growth, perhaps we shall find it in a conception of humanity, of human life, one in its fruitful past and pregnant present. Human life may well be held a universal and dynamic unity in its manifestations, past, present, and to come; though for our intellectual and classificatory convenience we divide it into branches.

And now, if our considerations are valid, it becomes clear in what spirit and with what thoughts in mind we should write and teach history. We should strive to maintain this twofold unity, that of the time-dimension of past and present, and the pervasive unity of human life through its divers manifestations in religion, philosophy, science, institutions, and conduct. We should teach and write history as the veritable mirror, the *alter ego*, of this vibrant whole and unity of human growth. No one can compass this universal story. But each of us may set forth what he has to teach so that all the facts shall be constituent, and each fact shall appear in its topical relationship and exhibit its causal bearing. The story, and every part of it, is a linked emergent growth; and the facts which possess the broadest rational and connective value will best show its succeeding stages. Through the choice of such cardinal and potent facts, perhaps we may be able to present our topic in its furthest truth—as a chord in the symphony of man.

An awful time-honored figure looms before us, demanding to be dealt with. Its name is "historical fact." Since our history, taught or written, is to be truthful, the very *alter ego* of the course of events, one must take pains to be accurate. There is no telling when some small accuracy may prove a luminous link in the causal sequence. But usually accuracy relates to details and circumstances rather than to the larger features of the story. How can one be accurate about the Battle of Salamis or the assassination of Julius Caesar?—even though one were a contemporary with access to the newspapers of the following day. One will look to them for obvious details, which buzz about the fact. As for the event in its more essential nature, the historian will have to construct it out of his best knowledge and intelligence. Using our points of data, we form a conclusion as to how the event must have taken place, or probably took place. This is what every historian does of necessity. When he has determined the

details, he has the more arduous task of their joinder and interpretation. Insight and judgment apply to this process, rather than accuracy. The result must be largely a matter of wise inference.

There are still two further considerations touching the conception of "historical fact." One is the human equation, and the other the multiple significance of every so-called fact.

Mark well the disturbing function of the human equation. Not merely is the fact's interpretation affected, in ways dependent on the interpreter's intelligence and bent of interest. But, beyond this, a molding and creative manifold of understanding enters and makes part of the fact itself. Caesar's death had different significance for each one of those Roman notables whose swords met in his body. It was differently intended, and also bore different results, according to the temperament, motives, and situation of each. Indeed it was for each a different fact. No fact can be in and of itself alone. Every fact comes to pass in its relationships and bearings, as well as in itself—if indeed there be any clearly marked and delimited *itself*. The causes of Caesar's death had worked up to it through the whole antecedent history of Rome—of mankind, if you will. More immediately it was brought about by the tempers and motives of the conspirators. Neither its causes, its manifold significance, nor its effects could be the same for an ethical intellectual like Brutus and for the sweaty mob about to take the air in Caesar's gardens beyond the Tiber.

Not only a striking event like Caesar's death, but every incident in life is exhaustless in its bearings; and since its substance extends to its relationships and effects, a multiplicity of actuality as well as meaning is very part of it.

But, furthermore, the understanding of a fact by contemporaries is part of its bearing and effect, and so part of the fact itself. This would, of course, apply to divergent understandings of it. Accounts that differ may be equally justifiable and equally true. Each one may set forth a different phase. Divergent histories, contemporary or future, may be each a receptacle and true expression of some actuality. But such histories are also part of the bearing and result of the fact, and so a part of it. And this is the ground of the justifiability, and indeed of the transcendent unity, of history as narrative and as one and the same with the course of the events described. As the events form an organic continuum, so should the expression be.

There is still a last complexity—perplexity it may seem. The very notion of fact, and what the real fact is, has varied marvellously among men; and this too, with no conscious weighing of the metaphysics of the matter. The phenomena, for example, of what we call the physical or natural world have been very differently viewed. Ordinary people accept them for what they appear. But the old Greek philosophers sought to find beneath them a profounder and causally explanatory fact. Such was the water of Thales, the atoms of Democritus, or the substance of Aristotle, or, if you will, the Ideas of Plato. None of these was either visible or tangible. Each was rather an explanation, an hypothesis, an assumed fact thrust forward, or thrust under, to explain things as they appeared. The nuclei and electrons of our modernized atoms may be a fact of this character. The ether at all events is such an explanatory fact, or hypothesis; and comes and goes at the call of physical theory.

Again, physical facts may be accepted symbolically; regarded as symbols of the verity which they carry, or which indeed they *are*, to the rightly instructed mind. The Church Fathers of the fourth and fifth centuries were prone to regard the facts of nature as symbols of the spiritual verity which it was their function to shadow forth. And, for some philosophers of the Middle Ages, the natural world, both in its creation and as presented before their eyes, was a divinely ordered allegory. Its actual reality, which appearances merely shadowed forth, lay in its spiritual and saving import.

As for so-called historical events, the Church Fathers, and after them the medieval theologians, admitted rather grudgingly the literal truth of the Old Testament narratives. That was but "the letter that killeth." The profounder verity, the deeper fact, was the salvation prefigured in them. It was their saving prefigurative meaning, which held "the spirit that maketh to live."

Some of us moderns, our Wordsworth for example, would still tend to find the deeper reality in the lesson, the teaching, the spiritual import of Nature. And in philosophy our extreme idealists, from Bishop Berkeley on, can find no reality beyond our thought.

Many of us to-day who are neither given over to allegory nor idealists of Berkeley's type still hesitate before our choice of fact or truth. We are haunted by the faith that the surest and most veritable fact is that which our whole human nature, passionate, spiritual and intellectual, might somehow conspire to substantiate. Fact may not be just as we see it, or scientifically observe it. And perhaps fact is not just as reason argues it. Assuredly it is not what impulse and emotional conviction would declare; our intuitions will not suffice. We crave the concurrent verdict—if we could only get it—of all the faculties of our cognitive and assertive selves.

Thus I have tried to set before you a layman's view, in which history shall not be mere narrative,

nor merely the series of events forming the past; but shall incorporate and be the onward-striding thought, the interwoven tissue of event itself, the element of continuity without which nothing is or can ever have been. Every object in nature, every bit of science, every philosophic theory, every phase and kind of religion, and every constructive or destructive act of life, possesses the constituent of being and becoming which is time. And the history of politics, of science, of philosophy, of art, or of religion, is politics, science, philosophy, art or religion in its genesis, its emergent growth, its present, or even future, culmination and decay, through which its elements pass into other phases of the cosmic process.

HENRY OSBORN TAYLOR

SAMUEL GARMAN—1843–1927

SAMUEL GARMAN or Samuel W. Garmann, as he styled himself during his early life, was born on June 5, 1843, in Indiana County, Pennsylvania, and died on September 30, 1927, at Plymouth, Massachusetts.

Although he was for a while a student in the Lawrence Scientific School, he did not graduate but received an honorary degree of B.S. from Harvard University in 1898 and an A.M. in 1899. Garman told the junior author that as a young man he took part in surveying the routes for the Union Pacific Railroad and that having left home very early, he fought Indians and shot meat for the working crews while hardly more than a boy. This was a strange beginning for one who became almost completely a recluse.

In 1870 he became, for a year, the principal of the Mississippi Normal School and in 1871 taught natural science, again for one year, at the Ferry Hall Seminary in Illinois. Always keenly interested in natural history, he went to California, met Professor Agassiz at San Francisco when the *Hasslar* docked there after her voyage through the Straits of Magellan and Agassiz, immediately appreciating Garman's potential usefulness, hurried him on to Cambridge at once where he became one of his favorite pupils.

The senior writer's first acquaintance with Garman dates from the inception of the Anderson School at Penikese. Here Garman was one of the little group who, with Professor Agassiz, laid the floor of the barn with their own hands, on that memorable Sunday before the day on which the first modern marine biological laboratory ever opened its doors to students. Garman kept the books of the school and helped in practical as well as in scientific matters. Then, and later when he returned from the west after fossil hunts in the Bad Lands, he appeared in a broad hat and a flaming red necktie. But even as a young man he possessed a most firm dislike for personal publicity. He saw in the West the rivalry of Cope and Marsh to secure each other's specimens and to forestall each other's descriptions of their discoveries. Moreover, the somewhat unkindly attitude which they maintained towards each other's work evidently impressed him very deeply, for all his life long he maintained a singular reticence and it was only after years of intimate friendship that he would discuss any scientific work which he had in hand. Indeed he habitually put away his manuscript and the specimens which he was dissecting when a visitor rang the bell to his room. This was not by any means all from a fear that others might anticipate his results, although he did at times have this fear, as was so commonly the case with the zoologists of a few decades ago, but rather because he disliked discussing any of his work until his studies were completed. Those who came to know Garman early in their career, and the junior author was one who worked at his side almost daily for many years, appreciated that gradually he became more warm and kindly in his companionship, while his thorough and most accurate methods of work and his methods of training were always of the very best.

Johannus Müller was his guiding genius and of American workers he had vastly more intellectual respect for Jeffries Wyman than for most of his immediate predecessors. His affection for Louis Agassiz and his lifelong friendship for Alexander Agassiz amounted almost to hero worship and betokened a fine spirit of loyalty.

For many years his biography was not to be found in "Who's Who" nor even in "American Men of Science," although in his field of science he was easily one of the world leaders. The senior writer remembers a gathering on Penikese Island in 1874, six months after the death of Agassiz. Each one then present expressed in his own way his indebtedness to the great teacher. Finest of all were the words of Garman, depicting "the best friend that ever student had."

Garman, in 1874, accompanied Alexander Agassiz on his survey of Lake Titicaca and occasionally when in an unusually expansive and reminiscent mood he could be persuaded to tell how once while perched on a high Andean precipice catching frogs, he shot, with his suspender button, a gigantic condor which regularly swung past him on outstretched wings finally to fall a prey to his ingenuity. The details varied a little from time to time and while always told with the utmost seriousness there was nevertheless an unmistakable twinkle in his eye.

Garman also served for a while as Alexander Agassiz's assistant on *The Blake* and this gave him the opportunity to visit most of the Antilles and to

ake the collection of reptiles which he described on is return.

Once established in the Museum of Comparative oology, Garman seldom left Cambridge, but settled own to a life of persistent work on certain groups of shes, a quiet career of graying age, one day much he same as another for over half a century. So eldom did he go upstairs to the museum library or xhibition halls that few students even knew him by ight, for he entered early and left late from his own ittle grilled door in the basement. Upwards of fifty apers on fishes, most of them of special value, and ncluding new facts and new material are listed in Dean's "Bibliography of Fishes" from 1875 to 1913. Of these the most important is the one latest in date, "The Plagiostomia (Sharks, Skates and Rays)." In his are given detailed descriptions of the known spe- ies, with 77 excellent plates depicting nearly all of hem. Of great value also is his report on the fishes f the deep seas collected by *The Albatross* under di- ection of Alexander Agassiz along the west coasts of tropical America. This is one of the most useful ontributions to our knowledge of the fauna of the eep seas. Other papers of importance are the Sela- hians (sharks) of the voyage of *The Blake*, the ac- ounts of *Chlamydoselachus* the frill-shark, regarded s the "oldest living type of vertebrates," which view is perhaps questionable; "The Discoboli," the "Cypri- nodonts" and the "Chimaeroids," besides detailed ana- tomical studies and accounts of new species.

Garman was a man of medium size, latterly rather ent over and spare. He loved his garden and work- ng there and with his bees kept himself in excellent physical condition until but a few years before his death. His library of fishes is one of the very largest ever gathered in private hands and by his generosity is now in the possession of the museum which he dearly loved and of whose staff he was one of the most distinguished members.

DAVID STARR JORDAN,
THOMAS BARBOUR

SCIENTIFIC EVENTS

THE NATIONAL RESEARCH COUNCIL OF ITALY[1]

HIS EXCELLENCY, PREMIER MUSSOLINI, the head of the government, on the first of the year, directed to the Honorable Guglielmo Marconi, president of the National Research Council, the following message, in which are fixed some of the fundamental objectives which should control the activities of the Council:

[1] From *La Tribuna*, of Rome, January 7, 1928. Translated and submitted to SCIENCE by Dr. John W. Lieb.

Mr. President:

The necessity of a coordination and regulation of scientific research, so intimately related at the moment to the technical and economic progress of the country, induces me to organize an instrumentality well equipped for this high national purpose. The interesting ("geniale") invention almost always originates in the brain of an isolated individual, but only the persistent work of patient investigators, with large and well adapted means, can efficiently develop and utilize it. A country like our own, poor in raw materials and dense in population, finds it absolutely necessary to have a thoroughgoing organization in order to be able to solve promptly difficult problems so as to avoid waste of energy, of money and of time.

To the National Research Council I have confided this duty, so full of responsibility. In its difficult task it can count upon my hearty support and to this end I intend to fix several fundamental objectives which should inspire its action and that of all of the bodies which will collaborate with it.

First. It is necessary to systematize in Italy research laboratories and well-equipped and live museums, in which the progress of science, of technology and of industry are rendered evident. A country does not spend in vain for such a progressive activity.

Second. The Research Council must have a care that Italian representatives in foreign parts, in the meetings so frequently held of technologists and scientists, should worthily represent our country and are dignified and well educated. I intend that these, my instructions, shall be respected in the most rigid manner. No official Italian delegation should go abroad to represent our country in the field of science or technology unless nominated by me on the recommendation of the Research Council. I beg that my colleagues in the government will assist in every way the directors of the council in discharging this not easy duty.

Third. The scientific and technical congresses which are held in Italy also, whether they are national or international, require to be regulated. These meetings will be authorized by me on the recommendation of the directors. No Italian delegate has the right to propose meetings in Italy of international scientific congresses without my specific authorization.

Fourth. I have intrusted the National Research Council with the not easy task of attending to the compilation of the Italian technical-scientific bibliography. The utility of this work is evident; it facilitates our scientific and technical progress which is essential to our economic welfare, and it is necessary for valorizing and recording in Italy the hard work done by our scientists also in comparison with other countries. It is necessary that everybody lends his cooperation with enthusiasm in this work of national interest, and everybody must answer with a ready response the questions asked by the National Council. It is my intention that all state, and public organizations in general, should support this truly Fascist undertaking.

Fifth. Very often government technical bureaus need

information and data about technical and scientific results accomplished in certain fields. The Research Council must see to it that the desired information is forwarded to the interested parties with promptness and accuracy. In this way, a service will be gradually unified, instead of having it, as it is now, divided amongst the various ministries with its great cost and waste of energy and which, on the whole, can be greatly reduced.

Mr. President, I am sure that the National Research Council will fully perform the task I am intrusting to it, and in that confidence I am sending my very best wishes to you and to the directors of the council.

January 1, 1928, VI.

MUSSOLINI

This message of the chief of the government constitutes an event of outstanding importance for the scientific and technical development of the country and, from several points of view, can rank with the speech of Pesaro, which marked the beginning of the economic rehabilitation of Italy.

The head of the government, after having reestablished the authority of the state, reorganized the finances and stabilized the currency, is now taking up again genially with this message the policy of expansion and affirmation of our people in all fields of intellectual activity and he desires that Italy reconquer again the function of predominance in scientific research which had its birth and flourished in our midst.

The organ of this revival will be the National Research Council, which the lofty mind of the Duce has desired to be presided over by the most genial investigator which Italy to-day possesses, Guglielmo Marconi, and by a directorate on which serve men distinguished for ability and culture: His Excellency Giannini, minister plenipotentiary; the Honorable G. A. Blanc, Professor Parravana, General Vacchelli, His Excellency Bonaldo Stringer, manager, and Professor Magrini, secretary general.

A National Research Council has been in existence since 1921, but on account of its peculiar organization it has not been able to obtain all the expected good results.

The national government, fully aware of the great benefits which such an institution could render to the nation, decided to promptly reorganize it and better define its juridical status and it has accordingly made it a permanent consultative and informative organ of the head of the government, and of the ministry of public instruction, for everything concerning the development and progress of scientific activity at home and abroad.

At the same time, in order to obtain the necessary information, he has given to the council the freedom of approach to the institutions, laboratories and establishments where scientific research is carried on.

The constitution of the National Research Council is as follows: A board of directors and ten national committees, one for each of the principal branches of science.

At the head of each committee there is an executive board consisting of a president, a secretary and three members. Each national committee has a number of members varying according to the development attained by the scientific branch it represents.

In addition, the National Board of Directors may propose from time to time to the head of the government the appointment of special national commissions for the study of specific problems which have a practical importance in the life of the nation.

The organization of several of these commissions has already been determined upon, and two of them, that for food and that for national fertilizers, will very soon initiate their work.

The head of the government in his important message, when referring to the tasks assigned to the National Research Council, speaks of the institution of well-equipped research laboratories.

The Duce thus stresses, interestingly, one of the most important items of the activities of the organization and points out with accuracy one of our deficiencies which must be removed.

Italy, among the nations of great cultural development, is the only one which has not as yet any institution for pure scientific research, and all technical progress is intrusted to university laboratories, which, on account of their predominantly didactic functions, can not take care of the development of science with the necessary energy.

It is, therefore, indispensable to equip some great institution so that it may completely satisfy through books and magazines, apparatus and instruments, all of the exigencies of the investigators and thus place the country in a position to contribute, equally with other nations, to the technical progress of the world, and meanwhile this order of the Duce will be executed at once.

The importance of the other functions which the National Research Council is called upon to perform is self-evident but we wish especially to refer to the compilation of the technical and scientific bibliography and its diffusion abroad in every center of study in order that the patient and often valuable (geniale) work of Italian scientists may no longer be ignored by anybody.

THE FARADAY MEMORIAL FUND

WILLIAM F. CASTLE, mayor of Southwark, writes as follows with regard to the Faraday memorial fund:

Michael Faraday was born in Southwark, the son of a

blacksmith whose forge stood not far from London Bridge and close to the present Southwark Town Hall and Central Reference Library.

To commemorate this great and unselfish pioneer worker, the council of his native borough purpose to form and maintain in connection with the Central Reference Library, a Faraday Memorial Library, to include a complete collection of portraits and biographies of Faraday and works containing contemporary references to him and his work; books showing the position of the physical sciences when Faraday began to work in them, and the best up-to-date works on those sciences and their latest developments.

For this purpose a Faraday memorial fund has been inaugurated, the annual income from which will be devoted to the acquisition of the best authoritative books as published year by year, and so keep the Memorial Library always abreast of developments in, and practical applications of, the sciences, especially electricity, for which Faraday did so much. In this way the memorial will have permanent vitality, perennial freshness, and ever-increasing usefulness, and like the benefits of Faraday's discoveries will be available for all who will to make use of it.

Some readers of SCIENCE may like to be associated with the Southwark Borough Council in this tribute to him. As mayor of this historic borough by the Thames-side, in whose annals are brilliant names of special interest to America—John Harvard, who, like Faraday, was born here, for example—I shall be happy to welcome tokens of America's interest, either in the form of contributions or of enquiries, addressed to me at the Town Hall, Southwark, London, S. E. 17.

THE WORLD ENGINEERING CONGRESS

A WORLD Engineering Congress is to be held in Tokio, October, 1929. The Congress proposes to discuss various engineering subjects in anticipation eventually of initiating and promoting international cooperation in the study of engineering sciences and problems in all its branches and to cultivate a feeling of brotherhood among the engineers of the world. Herbert Hoover, secretary of commerce, is honorary chairman of the American committee which is sponsoring the congress.

Seventy-eight prominent engineers in the United States have accepted appointments by Secretary Hoover, as members of the congress, including Thomas A. Edison, John Hays Hammond, Samuel Insull, William B. Mayo, of the Ford Motor Company; Charles M. Schwab, Samuel M. Vauclain, president of the Baldwin Locomotive Works; Daniel Willard, president of the Baltimore & Ohio Railroad; Orville Wright, Gen. William Barclay Parsons, James H. McGraw, of the McGraw-Hill Publishing Company; H. H. Westinghouse, of the Westinghouse Air Brake Company; Alfred P. Sloan, Jr., president of the General Motors Corporation; Michael I. Pupin, of Columbia University, and the following members of the General Electric Co.: E. W. Rice, Jr., honorary chairman of the board; Gerard Swope, president; C. C. Chesney, vice-president, and Professor Elihu Thomson, director of the Thomson Research Laboratory of the company.

Departments of various governments, universities, institutes and associations will take part in the sessions, which will cover a period of two weeks. Maurice Howland, secretary of the American committee, made the following statement:

> Some of the world's most pressing problems relative to public works, communication, transportation, power, chemicals, textiles and aeronautical and automotive engineering will come before the congress. At the outset, activity in these fields will be taken up under general groupings such as education, administration, statistics and standardization. The session will go on to specific problems under the heads of structural work, shipbuilding, mining and metallurgy, fuel, heating and ventilation, illumination, drainage, refrigeration, and the use of telephone and telegraph. Almost every activity of daily life as touched by modern science and invention will be reflected in the deliberations of the congress.

THE ST. LOUIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE seventy-fifth meeting of the American Chemical Society will be held in St. Louis from April 16 to 19. Dr. William J. Mayo, of the Mayo Clinic, will address a public meeting on the evening of April 17 on "The Advancement of Learning in Medicine through Biochemistry."

Preliminary plans have been announced for the scientific sessions. All except the colloid, fertilizer and leather and gelatin chemistry divisions will meet.

The agricultural and food chemistry division, in addition to holding a meeting for the presentation of miscellaneous papers, will hold a symposium on insecticides and fungicides under the leadership of R. C. Roark.

The division of biological chemistry expects twenty to thirty papers on the biochemistry of soils, nutrition, vitamins, ultra-violet irradiations, endocrinology and the relation of chemistry to health and disease.

The cellulose chemistry division will hold two half-day sessions.

The division of chemical education will hold four half-day sessions at St. Louis. Two of these sessions have been allotted to a symposium on "Analytical Chemistry," in which several prominent chemists have already agreed to take part. One of these sessions will be held at the time of the general divisional meetings on Tuesday afternoon, April 17. The topics for this particular session are: "Objectives and Content of

the Introductory Course in Qualitative Analysis"; "Objectives and Content of the Introductory Course of the Quantitative Analysis"; "Advanced and Graduate Work in Analytical Chemistry."

The history of chemistry division will hold one half-day session. The division expects to hold an exhibit of autograph letters, documents, medals, etc., relating to the French chemists of the French revolutionary period. Papers by H. M. Elsey, Orville E. May, Lyman C. Newell and Tenney L. Davis have been promised.

The division of industrial and engineering chemistry is planning to have round-table discussions on the following topics: "Lubrication," led by R. E. Wilson; "Filtration," led by D. R. Sperry, and "Equipment Construction," led by W. T. Read. The petroleum division will join in the discussion on "Lubrication."

In addition to a joint symposium with the division of physical and inorganic chemistry on "Atomic Structure and Valence," the division of organic chemistry will hold three half-day sessions.

The paint and varnish division will hold a symposium on "Settling of Pigments," with P. R. Croll as chairman. A number of other papers have been promised.

The petroleum division will hold three half-day sessions in addition to the joint round-table discussion on "Lubrication" with the industrial and engineering chemistry division. The division plans to visit one of the refineries in the neighborhood of St. Louis.

The division of physical and inorganic chemistry plans to devote a whole day to the joint symposium on "Atomic Structure and Valence." The purpose of this symposium is to try to bring physicists and chemists together in an effort to arrive at some common basis of understanding. The following speakers have promised to participate: K. K. Darrow, G. E. M. Jauncey, S. C. Lind, H. S. Fry, W. H. Rodebush, W. A. Noyes, W. D. Harkins, Herman Schlundt and W. H. Carothers.

The rubber chemistry division will hold three half-day sessions. It will also hold its regular banquet. The division of sugar chemistry will hold three half-day sessions.

At the meeting of the division of water, sewage and sanitation a group of papers will be presented on the treatment of water for railroad use, with special reference to softening; another group will have to do with recent advances in the softening of municipal water supplies; and the softening of water in the home will be discussed briefly. Some phases of the utilization of Colorado River water will be discussed in the light of new data on the dissolved mineral matter and the silt carried by the river.

The addresses of the secretaries of the divisions which will hold meetings are as follows:

Agricultural and Food Chemistry: C. S. Brinton, Food Inspection Laboratory, U. S. Appraiser's Stores, Philadelphia, Pa.

Biological Chemistry: M. X. Sullivan, Laboratory of Hygiene, Treasury Department, Washington, D. C.

Cellulose Chemistry: E. C. Sherrard, Forest Products Laboratory, Madison, Wis.

Chemical Education: R. A. Baker, Bowne Hall, Syracuse University.

Dye Chemistry: H. T. Herrick, Color and Farm Waste Division, Bureau of Chemistry and Soils, Washington, D. C.

Gas and Fuel Chemistry: O. O. Malleis, 5557 Woodmont St., Pittsburgh, Pa.

History of Chemistry: Tenney L. Davis, Massachusetts Institute of Technology.

Industrial and Engineering Chemistry: E. M. Billings, 343 State St., Rochester, N. Y.

Medicinal Products Chemistry: A. E. Osterberg, Mayo Clinic, Rochester, Minn.

Organic Chemistry: Frank C. Whitmore, National Research Council, Washington, D. C.

Paint and Varnish Chemistry: E. W. Boughton, New Jersey Zinc Co., 160 Front St., New York.

Petroleum Chemistry: Carl L. Johnson, The Manhattan Oil Co., Kansas City.

Physical and Inorganic Chemistry: Ward V. Evans, Northwestern University.

Rubber Chemistry: H. E. Simmons, Bierce Library, Municipal University, Akron, Ohio.

Sugar Chemistry: F. W. Zerban, New York Sugar Trade Laboratory, 80 South St., New York.

Water, Sewage and Sanitation Chemistry: W. D. Collins, U. S. Geological Survey, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

PROFESSOR JAMES KENDALL, dean of the New York University Graduate School and formerly professor of chemistry in Columbia University, has accepted the chair of chemistry at the University of Edinburgh. Dr. Kendall will succeed his old teacher, Professor Sir James Walker, of Edinburgh, who retires at the end of the present academic year.

COLONEL WILLIAM B. GREELEY, since 1920 chief of the U. S. Forest Service, will resign on May 1, to accept a position with the West Coast Lumber Manufacturers' Association. Major R. Y. Stuart, now assistant forester in the forest service in charge of public relations, has been appointed to succeed Colonel Greeley.

THE British Iron and Steel Institute will award the Bessemer gold medal to Charles M. Schwab, chairman of the board of the Bethlehem Steel Corporation and

president of the American Iron and Steel Institute. The presentation will take place at a meeting of the institute on May 3 and 4.

DR. MARCUS BENJAMIN, editor of the publications of the U. S. National Museum, has recently received the promotion from "Cavaliere" to "Officer" of the Order of the Crown of Italy.

THE grand cross, the highest rank of the Legion of Honor, has been conferred on Dr. Albert Calmette, of the Pasteur Institute, who has developed a preventive vaccine treatment for tuberculosis. His collaborator, Dr. C. Guerin, has been accorded the rank of officer.

DR. A. W. HILL, director of the Royal Botanic Gardens, Kew, who is on a visit, made possible by a grant to Kew from the Empire Marketing Board, to the botanical, agricultural and forestry institutions of Australia, New Zealand and Java, has been given the degree of D.Sc. by the University of Adelaide.

ACCORDING to the *British Medical Journal* the prize of the Marchiafava Foundation of the value of 8,000 lire for the best work on morbid anatomy and experimental pathology has been awarded to Professor Soli, who holds the chair of morbid anatomy at Palermo, for his investigations on arterio-sclerosis produced by *Spiroptera sanguinolenta*, and Professor Brancati, of the Surgical Clinic of Rome, for his investigations on internal tar cancer.

AT a meeting of the British Institution of Electrical Engineers held on February 2 a portrait in oils of Mr. Ll. B. Atkinson, past-president of the institution, was formally presented to the institution by the Cable Makers' Association. The portrait was painted by Mr. G. Harcourt.

DR. GUSTAV GIEMSA, director of the chemical section of the Hamburg Institute for Tropical Diseases and the inventor of a well-known stain, recently celebrated his sixtieth birthday.

PROFESSOR MINKOWSKI, who retired last year from the directorship of the medical clinic at Breslau, celebrated his seventieth birthday on January 13.

MORE than one hundred of his present and former associates and friends gathered at the Cosmos Club on the evening of February 3, 1928, to do honor to F. P. Veitch, who directs the research work on leather, paper, fabrics and naval stores of the Bureau of Chemistry and Soils. The celebration was to commemorate his twenty-five years of service in the Bureau of Chemistry. It took the form of a dinner, at which W. W. Skinner presided as toastmaster.

PROFESSOR SAMUEL C. LIND, director of the school of chemistry of the University of Minnesota, has been elected a member of the International Radium Standards Commission, to succeed the late Professor Boltwood, of Yale University.

DR. R. E. ROSE has been appointed a member of the advisory committee of the cancer research fund of the University of Pennsylvania.

STANLEY F. MORSE, consulting agricultural engineer, of South Carolina and New York, has been appointed chairman of the newly-organized division of consulting agricultural engineers of the American Society of Agricultural Engineers. The purpose of this division is to bring together in one organization the most competent men in the profession. The qualifications of applicants will be examined and only those of proper training, experience and reliability will be admitted to membership.

GEORGE A. STETSON has resigned as associate professor of heat-power engineering at New York University to become associate editor for the American Society of Mechanical Engineers.

PROFESSOR S. C. LANGDON has dropped his teaching work at Northwestern University to take charge of chemical research for the Curtis Lighting, Inc., of Chicago. He will continue to direct some of his researches at the university.

FACULTY members from foreign countries who will give summer quarter courses at the University of Chicago include P. W. Bryan, lecturer on geography at the University College, Leicester, England, and John Robert Charles Evans, geology, Brandon College, Manitoba, Canada.

L. C. COLEMAN, who was granted two years' leave of absence by the department of agriculture in Mysore, India, and has been, during that time, professor of plant pathology at Toronto University, has returned to India to again become director of agriculture in Mysore at Bangalore.

A. R. TRIST, research forester of Australia, has been sent to the United States by the Australian government for a stay of two years to study the organization of the forest experiment stations and the methods involved in forest research in the United States.

SIR WILLIAM B. HARDY, of Cambridge, England, will be the guest of honor at the sixth National Colloid Symposium, to be held under the auspices of the American Chemical Society in Toronto from June 14 to 16.

DR. JULIUS BAUER, professor of medicine at the University of Vienna and physician in chief to the Polyclinic, will deliver several lectures and also the convocation oration before the American College of

Physicians at the meeting in New Orleans, from March 5 to 9.

Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research, will address on March 15 the Columbia University chapter of the Society of Sigma Xi, on "Research on Plants as exemplified by the Work of the Boyce Thompson Institute."

Dr. Gerald Wendt, director of the new Battelle Memorial Institute at Columbus, Ohio, will make a lecture tour of the West during the months of February and March. He will deliver three different lectures at a number of colleges and universities, including a popular lecture on "What is the World made of?" and two lectures of special interest to scientists, especially chemists, on the "Creative Artist in Research" and "American Chemical Research in 1928." This is the first of a series of lectures being planned for the institutions in the far west and is being arranged by Dr. J. L. St. John, head of the department of biochemistry in the State College of Washington.

Dr. C. M. A. Stine, chemical director of the E. I. du Pont de Nemours Company, on a recent trip to the Pacific Coast, gave talks before various organizations. On January 13 he addressed the Society of Sigma Xi at the University of Washington on "High Pressure in Manufacturing."

Dr. Henry Laurens, professor of physiology at Tulane University Medical School, recently gave lectures on "The Physiological Action of Radiant Energy," before chapters of the Society of Sigma Xi at the University of Missouri and the University of Kansas.

Dr. Arthur H. Compton, professor of physics in the University of Chicago, lectured before the West Virginia Chapter of the Society of the Sigma Xi and the West Virginia Scientific Society on February 23. His subject was "What Things are made of."

Dr. Ulric Dahlgren, professor of biology at Princeton University, read a paper on March 2 before the American Philosophical Society on "Equilibrium and Hearing."

On February 11 Professor R. A. Gortner, chief of the division of agricultural biochemistry, University of Minnesota, delivered an address to the Royal Canadian Institute on the subject "Colloid Chemistry and Living Processes."

Industrial and Engineering Chemistry notes that the year 1928 marks the hundredth anniversary of Wöhler's preparation of urea from ammonium cyanate. That discovery marked the beginning of synthetic chemistry and the beginnng of the end of the older vitalistic ideas of organic chemistry. It is planned to celebrate the centenary by a special program at the Boston meeting (Swampscott) of the American Chemical Society in September, 1928.

The centenary of the birth of Dr. Maximovitch, who was a distinguished Russian botanist, was recently celebrated by ceremonies in the town of Sapporo on the isle of Hocksido, Japan. The occasion was presided over by Professor Kingo-Miyabe, of the Institute of Natural Sciences.

A memorial plaque was recently unveiled in the medical clinic of Münster in honor of F. W. A. Sertürner, the discoverer of morphine, who was born at Neuhaus, near Padeborn, in 1783.

William Corless Mills, curator of the department of archeology in the Ohio State Museum, died on January 17, aged sixty-eight years.

John Rowley, curator of mammals for the California Academy of Sciences, died in January, aged sixty-one years.

Bradshaw Hall Swales, of Detroit, honorary assistant curator of birds in the U. S. National Museum, died on January 23, at the age of fifty-two years.

Willet Martin Hayes, formerly professor of agriculture at the University of Minnesota and later assistant secretary of the U. S. Department of Agriculture, died on January 15, aged sixty-nine years.

Dr. Edward S. Burgess, formerly professor of natural science at Hunter College, New York City, died on February 23, aged seventy-three years.

Professor José Rodriguez Carracido, for many years rector of the University of Madrid, who worked chiefly on the action of alkaloids upon organisms and was the author of several text-books on biochemistry, has died, aged seventy-two years.

The officers of the Louisiana Academy of Sciences met at Alexandria on January 28 at the Louisiana College. Those present were: I. Maizlish, H. L. Smith, Geo. Williamson, Jno. A. Hardin, F. M. Witherspoon, Leo J. Lassalle, Paul M. Horton, S. T. Sanders, H. V. Howe, A. C. Maddox, H. G. Shaw, F. G. Fournet, C. Cottingham, J. E. Guardia, O. B. Owens and A. L. Ducournau. Plans for the first annual meeting, which is to be held on May 5, were discussed as well as some of the future plans of the academy.

The Ohio Academy of Science will hold its thirty-eighth annual meeting at the University of Cincinnati on April 6 and 7, under the presidency of Dr. Harris

M. Benedict, of the University of Cincinnati. Among the prominent outside speakers will be Dr. W. T. Bovie, of the Medical School, Northwestern University, and Dr. W. W. Lepeschkin, now at the University of Illinois, botanical department. The former will speak on the "Relation of Physics to Biology" and the latter on "Physico-Chemical Causes of Death." President Schneider, of the University of Cincinnati, will also speak. The Indiana and Kentucky Academies of Science have been invited to attend and participate.

THE executive committee of the American Society of Zoologists has voted to hold the 1928 meeting in New York from December 27 to 29, inclusive.

A CONFERENCE was held at the U. S. Bureau of Standards on March 2, to discuss the research work on electroplating that is completed or in progress, and to make recommendations regarding future studies, both by the bureau staff and by research associates of the American Electroplaters' Society.

THE American Society for the Control of Cancer will hold its annual meeting on March 3 in New York. In the morning, Dr. Francis Carter Wood will demonstrate modern cancer research at the Crocker Laboratory; Henry F. Vaughan, D.P.H., health commissioner of Detroit, will speak at a luncheon at the Biltmore Hotel on "Functions of Health Departments in the Control of Cancer," and Dr. Jonathan M. Wainwright, Scranton, Pa., on "What the Medical Profession should do about Cancer." Short discussions of cancer control in its practical aspects and a short business meeting will take up the afternoon.

THE date of the Third Annual Meeting of the Eastern Section at the University of Virginia (Charlottesville, Va.) has been arranged. The first session will convene on the afternoon of Monday, April 30. Sessions for the presentation of papers, etc., will occupy the afternoon of Monday, the morning of Tuesday and that of Wednesday, and, possibly, Wednesday afternoon also. Tuesday afternoon, May 1, will be devoted to excursions which are being arranged through the local committee. The chairman of the local committee is the president of the Virginia chapter of Sigma Xi, Professor Wilbur A. Nelson, University of Virginia, Charlottesville, Va.

AT a banquet in the Hotel Somerset on February 18 the centenary of the *Boston Medical and Surgical Journal* was commemorated. The first issue appeared February 19, 1828. With its next issue, the periodical will change its name to the *New England Journal of Medicine*, including also the states of Vermont and New Hampshire in its representations.

DR. HERBERT E. IVES, who was recently awarded the John Scott medal and premium, for his contributions to electrical telephotography and television, has donated the amount of the premium ($1,000) to the Optical Society of America, to found and endow a medal. This medal, to be awarded every two years, for distinguished work in optics, is to be named "The Frederic Ives Medal," in honor of the donor's father.

A JOINT resolution to provide $10,000 for expenses of an American delegation to the Eighth International Dairy Congress, in London during June and July, was passed by the House on January 26. Under terms of the resolution, the President will accept the invitation of the British government and appoint ten delegates to represent the United States.

THE U. S. Senate passed on February 6 the bill introduced by Senator McNary, of Oregon, authorizing an appropriation of $40,000,000 to be expended over a period of eight years to aid the various states in the purchase of denuded lands for reforestation purposes where reforestation is needed to protect the navigation of streams.

DESIGNATION of the American Green Cross as a national body for education and research work in connection with the protection of forests, flood control and allied problems, is provided for in a bill (H. R. Res. 196) just introduced in the House by Representative Evans, of Glendale, Calif. The bill authorizes appropriation of $120,000 to be placed at the disposal of the American Green Cross for the continuance and development of its organization. The bill was referred to the committee on education.

THE Iowa Lakeside Laboratory, situated on West Okoboji Lake in northwestern Iowa and operated in connection with the graduate college of the State University of Iowa, will be open to investigators during the season of 1928 from June 11 to August 17. No formal courses are offered, but research students in any field who find the conditions favorable for their work may be admitted to the laboratory. Supervision of research in experimental embryology and comparative physiology will be by Professor Emil Witschi and Otto M. Helff, of the department of zoology of the university, and in mycology by Professor G. W. Martin, of the department of botany. Professor Martin has been appointed director of the laboratory.

THE botanical specimens of the late Ellsworth Bethel, of Denver, have been given by the trustees of the State Historical Society to the Colorado Agricultural College and the University of Colorado. The Bethel collection proper consisting of some 10,000 mounted specimens and a much larger number of unmounted Colorado plants was received by the botanical department of the agricultural college. The col-

lection is a valuable one as representative of the region.

The sum of $10,000 has recently been granted to the American Philosophical Association by the Carnegie Corporation of New York City for the preparation of a series of *Source Books in the History of the Sciences*. They will be under the general editorship of Professor Gregory D. Walcott, of Hamline University, St. Paul, Minn. The volumes will present the most important contributions of the most eminent scientists from the Renaissance to the present. Seven different fields of science are being covered by special committees under the supervision of the following: Frederick Barry, professor of chemistry, Columbia University; Joseph S. Ames, professor of physics, the Johns Hopkins University; Harlow Shapley, professor of astronomy, Harvard University; Alfred M. Tozzer, professor of anthropology, Harvard University; David Eugene Smith, professor of mathematics, Columbia University; Edwin G. Conklin, professor of zoology, Princeton University; R. T. Chamberlin, professor of geology, University of Chicago. The first volume, on astronomy, will be ready for publication within the next few months.

The Smithsonian Institution has engaged to prepare a series of twelve books to be known as the Smithsonian scientific series, under the general editorship of the acting secretary. It is the purpose of the series to give pictures of the activities of the whole institution and its branches. The publication is not intended for the specialist nor in any sense is it a collection of monographs, but is rather intended to present those features of the greatest interest to the average intelligent reader with no special training along technical lines. It is expected that the individual books of the series will come out at various intervals during the next two years.

At the recent meeting of the board of managers of the Wistar Institute of Anatomy and Biology, Philadelphia, the titles of professor and assistant professor were discontinued and a new series of titles designating members of the scientific staff were adopted. As the chief function of the institute is the promotion of research in biology the following titles were adopted as being most appropriate: Member, associate member, associate, and fellow. At the same meeting Dr. Helen Dean King was elected a member of the institute.

Errata. In the article by Dr. G. De Geer on the "Geochronology as based on Solar Radiation" (Science, 1927, LXVI, p. 458), in line 14 of the second column for "this" read "the," in line 22 of the fourth column omit the words "already made" and in line 37 of the fifth column for "non" read "now."

UNIVERSITY AND EDUCATIONAL NOTES

The income from a bequest of $100,000 from the late Thomas U. Coe, of Bangor, which has recently become available at the University of Maine, is to be used as a foundation for research. Projects bearing on the developing of the state are to be submitted by the faculty for approval under this fund.

The chemistry building of the South Dakota State College, Brookings, S. Dak., was totally destroyed by fire on February 4, 1928. All records and material are a total loss.

Sir Arthur Shipley, late master of Christ's College, left £5,500 to Christ's College for the endowment of a fellowship, along with various other bequests, including some relics of Darwin.

The Rio de Janeiro correspondent of the *Journal* of the American Medical Association writes that the president of the Minas Geraes has signed the law creating a state university. This will include at first four colleges, namely, law, engineering, medicine and odontology and pharmacy. The medical school will have an annual endowment of 600,000 milreis (about $72,000).

Dr. C. W. Hungerford, professor of plant pathology in the agricultural college of the University of Idaho, has been appointed assistant dean of the college of agriculture and vice-director of the Idaho Agricultural Experiment Station.

At the University of California, Dr. Chauncey D. Leake, associate professor at the University of Wisconsin, has been appointed professor of pharmacology, and Dr. Alfred C. Reed has been appointed professor of tropical medicine in the George Williams Hooper Foundation for Medical Research.

Dr. Laurence Selling, Portland, has been appointed clinical professor of medicine and head of the department of medicine of the University of Oregon Medical School.

Dr. Willis Dew Gatch has been appointed head of the department of surgery, including gynecology and orthopedic surgery, in the Indiana University School of Medicine, succeeding the late Dr. John H. Oliver.

Wilson F. Brown, instructor in chemical engineering at the Ohio State University, has been appointed to an associate professorship at the Kansas Agricultural College, to take charge of the work in industrial chemistry and chemical engineering.

Dr. Gustav Hertz, professor of experimental physics in the University of Halle, has been appointed to succeed Professor Kurlbaum as professor of physics at the Technische Hochschule, Berlin.

DR. F. HUND, of Göttingen, has been called to an associate professorship of theoretical physics at the University of Rostock.

DISCUSSION AND CORRESPONDENCE

THREE NOTABLE BOOKS ON THE HISTORY OF MATHEMATICS OF THE GREEKS

THE Belgian engineer, Paul Ver Eecke, inspector general of labor, has made three notable contributions to enrich our knowledge of Greek mathematical science. While the works of Archimedes, Apollonius and Diophantos have long been available to English students through the learned labor of Sir Thomas L. Health, there have not been available modern editions in French. The Belgian scholar performs this service for French readers. The titles of these works are as follows:

Les Oeuvres Complètes d'Archimède, (Paris-Brussels, 1921; LX, 554 pp. with 253 diagrams). Price 20 belgas.

Les Coniques d'Apollonius de Perge, (Bruges, Desclée de Brouwer & Co., 1923; LII, 645 pp.). Price 20 belgas.

Diophante d'Alexandrie. Les six livres arithmétiques et le livre des nombres polygones. Oeuvres traduites pour la première fois du Grec en français. Avec une introduction et des notes. (Bruges, 1926; LXXXXII, 300 pp.). Price 15 belgas.

These volumes are all fine specimens of the printer's art, an ornament to any library. A further volume is in preparation on the Spherics of Theodosius of Tripoli.

In all three volumes Mr. Ver Eecke demonstrates his familiarity with the field of Greek mathematics. The notes given constitute a source of information to which historians of science must have recourse in the many problems connected with these authors.

Particular attention has been paid by the author to the importance of the works of Archimedes, Apollonius and Diophantos in the development of European mathematics during the seventeenth and eighteenth centuries. It is highly desirable to stress this point since through these classical works the ancient mathematics became the source of inspiration for the modern mathematics. The birth of the analytical geometry and of the calculus connects thus directly with the mathematics of Greece.

It is the hope of the publishers that a number of American libraries will subscribe to the series. The price per volume is under three dollars and is much less than works of this character published elsewhere in Europe or in America. The publication performs a real service to scholarship, and must have constituted a serious financial problem at the present time for the publishers. The two later volumes have been issued with the support of the Fondation Universitaire de Belgique.

LOUIS C. KARPINSKI
UNIVERSITY OF MICHIGAN

ON MOLECULAR DIAMETERS IN GAS REACTIONS

IN a recent note published in this journal,[1] Dr. Bernard Lewis has called attention to a numerical error in our paper entitled "On Chemical Activation by Collisions."[2] We are of course very sorry that this error occurred and desire to thank Dr. Lewis for calling attention to it.

However, on the basis of the revised figures our friendly criticisms of the Fowler and Rideal[3] theory of chemical activation by collisions, using ordinary kinetic theory diameters for unactivated molecules, are not greatly altered.

It would still be necessary on the basis of the revised figures to assume that the *deactivational* diameter for N_2O_5 is considerably more than 60 times as great as the *activational* diameter, if the rate of activation is to be great enough to maintain the reaction first order down to a pressure of 0.05 mm. And this assumption is attended by the difficulties which we pointed out in the next to the last paragraph of our article, namely, that in a deactivational collision molecules which come within the large distance given by the deactivational diameter will mysteriously be drawn together to the much smaller distance corresponding to an ordinary kinetic theory collision and will then fly apart in deactivated states.

On the other hand, it no longer appears that the deactivational diameters would have to be so great that the effective volume of an activated molecule would be large enough to contain many ordinary molecules at 0.05 mm. pressure. Allowing, however, a reasonable excess in the rate of activation over that of reaction, we still find that the effective volume of the activated molecules is large enough to contain several other molecules and this is a notion which gives rise to considerable difficulty.

Finally, we may call attention again to a consideration which bears no relation to diameters, namely, that it certainly would be very surprising if the collision of chemically unactivated molecules having sufficient energy to activate one of them, should practically always result in the transfer of nearly all of the energy to one of the molecules.

RICHARD C. TOLMAN,
DON M. YOST,
ROSCOE G. DICKINSON
PASADENA, CALIFORNIA

[1] SCIENCE, 66, 331 (1927).
[2] *Proc. Nat. Acad.*, 13, 188 (1927).
[3] *Proc. Roy. Soc.*, 113, 571 (1927).

ANOTHER RECORD OF THE FRESH-WATER JELLY-FISH

DR. SCHMITT'S recent notice[1] in SCIENCE prompts the recording of the following data. On November 30, 1927, a small "balanced" glass tank in the laboratory of the New York Aquarium was noted to contain a number of medusæ. These were referred to the *Microhydra* stage of *Craspedacusta sowerbii* (Lankester). The conditions under which they appeared were as follows. The aquarium measured 20″ by 12″ by 12″ and was exposed to a strong northwestern light. The temperature of the water ranged from 20° to 28° C. It contained a dense growth of various kinds of aquatic plants, which for the most part were being choked off by a thick mat of algæ that, however, did not grow on the glass. There were living in it about ten young Pœciliidæ of undetermined species from San Domingo (probably *Heterandria versicolor* Günther). Most of the plants came from Wilmington, North Carolina, about a month earlier and it is supposed that they are responsible for the introduction of the organism, for the other plants had been living in the aquarium for at least a year. It is thought unlikely that the medusæ were brought from San Domingo with the fishes or that they were introduced with the tap-water used for this aquarium.

The medusæ increased in number up to about December 1, and from then on to the present date, December 22, have gradually fallen off, so that they number probably less than a dozen, whereas at their highest concentration there were at least four or five to the cubic inch. At all times they could be seen either pulsating their way upward or slowly descending in an inverted position.

Dr. Ruth Howland, of Washington Square College, has had one of her students, Mr. S. J. Gancher, studying their development and he has succeeded in finding a number of the hydroids. To date none has been seen to bud off medusæ, nor have the medusæ been seen to develop into mature *Craspedacusta*.

By transferring some of the plants into another tank a new colony was established, although it did not thrive very well and at this date none could be found.

C. M. BREDER, JR.

NEW YORK AQUARIUM

CONCERNING THE TRANSMISSION OF AN ACQUIRED CHARACTER IN FLAX

IN SCIENCE of September 30, 1927, Dean Henry L. Bolley suggested that the resistance of a plant to flax wilt is an indication of the transmission of an acquired character. The general conclusion drawn in his article does not seem to be warranted by the facts presented, especially since the inheritance of acquired characters has been so often disproved. The writer agrees with Dean Bolley in that a wilt resistant flax may be rapidly obtained and it can then transmit its resistance in succeeding generations. The point of criticism is that the wilt resistant characteristic is in all probability present in the beginning and is not observed so strikingly at first, due to the large percentage of susceptible plants that succumb to the disease. With the susceptible plants dead and no longer producing seed, the seed obtained from the wilt resistant plants, when sown another year, show a higher percentage of survival than the original planting. Thus, after a few years, a highly resistant strain of flax might be obtained due to the plants of different degrees of susceptibility dying off or merely a "survival of the fittest." While the above happens in many mixtures of flax it might also occur in the so-called pure line, the term pure line in these cases being relative and not absolute. A variety of flax may be called a pure line for certain characters because these characters have been studied and are known to be pure. However, if the wilt resistance is not one of the characters included in the previous study it may not be a pure line for wilt resistance. This is indicated by the results obtained in Michigan with selections that originated from a relatively pure line. When grown upon wilt-free soil these selections were not different from the parent in yields of seed, deseeded straw and fiber. The statistical odds determined by Students Method for six selections, for these three characters are 1:1. But when grown on wilt sick soil, the significant differences in performance of different strains indicate a rather wide variation in resistance to flax wilt. One selection, showing no difference under wilt-free conditions gave odds of 9:1 for germination (emergence of seedlings) and 500:1 for per cent. of normal plants to seeds sown. Another selection gave odds of 93:1 for germination in wilt sick soil and only 8:1 for per cent. of normal plants to seed sown. The seeds in these tests were of Russian origin and, so far as is known, had been grown upon non-wilt sick soil. The possibility of variation due to crossing must be considered. In Michigan, where the flax was grown, tests have shown from zero to three per cent. natural crossing, depending on the spacing and seasonal conditions. It seems probable that the variation in wilt resistance may be due to unselected factors in an otherwise pure line or possibly to natural crossing rather than a gradual change in a hereditary gene.

B. B. ROBINSON

FIBER INVESTIGATIONS,
U. S. DEPARTMENT OF AGRICULTURE

[1] "Additional records of the occurrence of the fresh-water jelly-fish." Schmitt, Waldo L., SCIENCE, Vol. LXVII, 1927, p. 591.

THE BEGINNING OF WINTER

IN the discussions relating to the beginning of winter that have appeared from time to time in SCIENCE, one phase of the question seems to have received hardly sufficient attention.

If we look up what the Century and Standard Dictionaries have to say about winter or the seasons, we find that historically and, apparently until recent times, popularly, the general conception of winter was that it covered the three coldest months of the year. The idea involved was simply our experience of average meteorological or climatic conditions. In most parts of the north temperate zone the interval from the first of December to the end of February was regarded as representing this period, and modern meteorological data seem to indicate that this does represent a satisfactorily close approximation. The exact beginning of the coldest period doubtless varies somewhat in different regions. In the District of Columbia it falls on the seventh of December;[1] in Minneapolis apparently about the third of December.[2]

More recently there has been manifest a growing tendency, especially in the United States, to change this conception and to assert that winter should be regarded as beginning with the winter solstice and ending with the vernal equinox. As nearly as I can ascertain, this is due to a certain number of astronomers, with the enthusiastic support of a multitude of newspaper scientists. The favorite expression of the latter group is that "astronomically considered, winter begins at the winter solstice." Of course, "astronomically considered," winter does nothing of the kind. If it is possible to consider astronomically an event which is not astronomical in nature, it is the middle of winter that, in the northern hemisphere, should be regarded as coinciding with the solstice, for it is at the solstice that the sun appears farthest to the south, the day is shortest, and the heat received per second on unit area of horizontal surface is a minimum. As a matter of fact, however, there is a lag in the seasons such that the coming of winter is considerably delayed, though not to the degree that would cause its beginning to coincide, even approximately, with the solstice. As far as winter is concerned, the solstice is the solstice, and nothing more.

In spite of ancient usage, it might be desirable to modify the conception of the term winter, if any good reason could be advanced for making the change, but all the argument seems to point in the contrary direction. To nearly every one, scientific men and laymen alike, the coldest quarter of the year, the hottest quarter, and the quarters of intermediate temperature are of direct personal interest and importance. They govern many of our daily habits, plans and activities. To very few people except astronomers are the solstices and the equinoxes of more than general interest. Educated people are supposed to have a fair idea of their significance and time of occurrence, but to enforce this knowledge by erecting them as monuments by which to date the seasons hardly seems wise. It is not the way to teach science or respect for science. In fact, it seems to be generating a distinctly wrong impression. Many people seem to have acquired the idea that something occurs at the solstice which, according to the laws of nature, definitely fixes this as the beginning of winter. They do not realize that to declare that winter begins at the solstice is as arbitrary as it would be to declare that it begins on the nineteenth or the twelfth or the twenty-fifth of December.

There is evident at times an unfortunate tendency on the part of one or another group of scientific workers to take a word of general usage and give it a special meaning which adapts it better to their particular purposes, and then to insist that this should be accepted as the essential meaning. If astronomers find it useful to have a name for the period from the winter solstice to the vernal equinox, it would be desirable, in order to lessen the misapprehension and confusion that are resulting, to choose another term than winter. Failing this, they should be especially careful to point out to inquirers that their use of the word is in a special sense, which does not affect and is not intended to supersede the old-established meaning.

C. N. FENNER

GEOPHYSICAL LABORATORY,
WASHINGTON, D. C.

[1] W. P. White: SCIENCE 62, 286.

[2] C. H. Briggs: SCIENCE 65, 424.

QUOTATIONS

ONE TOOTH GONE WRONG

THIS week's excitement about the "million dollar tooth" from Nebraska is a trifle belated. It is now two months since Dr. William K. Gregory, one of the original examiners of this famous tooth, decided that it had belonged neither to an ape nor a man and published this conclusion in SCIENCE. No evolutionist slept less well for this explosion of the tooth's significance. To correct conclusions that turn out to be false is a continual duty of scientific men, and even false assumptions not infrequently result in progress by uncovering facts or engendering ideas previously unknown. It is to be noted, too, that the scientists who now reject the man-like origin of the Nebraska tooth are the same who originally accepted it. They are merely correcting a mistaken theory which they previously proposed, something which all scientific men do almost daily and as a matter of course.

To imply that the theory of evolution is in the least endangered by this discovery of a mistake about a single fossil is as though a bridge builder abandoned his bridge and helped to destroy it because a single girder, not yet built into the structure, was found defective on the testing floor. Certainly no evolutionist believes that the theory is impaired. Had the tooth proved really to belong to some man-like or ape-like creature, that might have meant something about the history of the New World monkeys. It would neither have strengthened nor weakened materially the idea that evolution is a fact.

To have the public interested in science is a great advantage to both parties, but not entirely free from danger. Scientific research going on in a show window might mislead watchers who tarry too short a time to understand what it is all about. When first found the Nebraska tooth was heralded popularly beyond its real importance. Doubtless its fall will be too widely hailed now as another "mistake" of the scientists. In truth it is but a trivial incident in the slow rise of the edifice of science. The theory of evolution is far too hardy a creation to be ruined by losing one tooth.—*New York Herald-Tribune.*

SCIENTIFIC BOOKS

The Abilities of Man, their Nature and Measurement. By C. SPEARMAN. New York, The Macmillan Co., 1927. vi + 415 + xxxii pp.

THE Grote professor of philosophy of mind at the University of London has written an important book. It could not be otherwise when the book represents the cumulation of intellectual endeavor for a period of a quarter century by such as he. It may well be that he does not know exactly what his theories and facts signify; it is certain that I do not. The work has been supported during its progress by the collaboration of a multitude of Spearman's pupils and by others, it has drawn widely upon the investigations of other schools, it has also had constant opposition and the book has been severely criticized in a review in *Nature* (August 6, 1927, p. 180) which has led to an interchange of views between author and reviewer (*Nature,* November 12, 1927, p. 690). Into this difference I will not enter except to say that whether the book is mathematically complete or not does not interest me; this is unimportant. Science advances not so much by the completeness or elegance of its mathematics as by the significance of its facts. You can not upset the findings of the "Origin of Species" either by the contraposition of your religious convictions or by observing that Darwin's statistical technique was not up to standard. Science goes forward upon "evidence beyond reasonable doubt"; to that evidence incomplete mathematics may contribute valuable elements.

Spearman's chief thesis is that when a group of persons x, y, z, . . . are given a test *a*, say of arithmetic or spelling or literary interpretation, the marks m_{ax}, m_{ay}, m_{az}, . . . which they score represent in part their respective general intelligences g_x, g_y, g_z, . . . and in part their special abilities in the subject, s_{ax}, s_{ay}, s_{az}, . . . This would seem incontrovertible provided we mean by ability in the subject, ability to get scores in the test. The necessity for this proviso may be illustrated as follows. I have some general intelligence; I have some mathematical ability; yet if an examiner should set me a mathematical test in Yiddish, which might be "easy meat" for a lot of candidates for admission to our colleges, I should miserably fail. It may further be remarked that the scores m_{ax}, m_{ay}, . . . may depend on the manner of scoring used by the examiner or his clerk. For example, if the test be of the simple sort where a large number of questions are answered yes or no, one method of scoring is to count the number of right answers, R_x, R_y, . . .; another method is to take the difference between the numbers right and wrong $(R-W)_x$, $(R-W)_y$, ... If all the N questions are answered, the scores are equivalent since $W = N - R$ and the series of scores R_x, R_y, . . . and $2R_x - N$, $2R_y - N$, . . . are in the same order, will give the same correlations with other tests, etc. But if some of the questions are unanswered (U), the second series becomes $2R_x - U_x - N$, $2R_y - U_y - N$, . . . which need not be equivalent to R_x, R_y, ... How are we to compare the answers of two persons to 50 questions if one answers 40 all correctly and the other answers all 50 with 45 right and 5 wrong?

The next thesis is that when a battery of tests *a, b,* . . . are sufficiently different, so that the scores may be assumed to have in common only the general intelligence we may write for the nk marks of the n individual x, y, z, . . . on the k tests *a, b,* . . .

$$\begin{aligned} m_{ax} &= c_a g_x + s'_{ax} & m_{bx} &= c_b g_x + s'_{bx} \\ m_{ay} &= c_a g_y + s'_{ay} & m_{by} &= c_b g_x + s'_{by} \end{aligned} \qquad (1)$$

in such a manner that the general intelligence g and the special abilities s′, are uncorrelated, *i.e.*,

$$\Sigma g_x s'_{ax} = 0, \qquad \Sigma g_x s'_{bx} = 0, \ldots \qquad (2)$$

$$\Sigma s'_{ax} s'_{bx} = 0, \qquad \Sigma s'_{ax} s'_{cx} = 0, \ldots \qquad (3)$$

when the summation runs over the individuals x, y, z, ... This leads to some correlation algebra to prove both that such a resolution of the marks is possible and that it is unique. I have read the proofs with care (including the references to the literature,

not all of which has been reproduced in the book) and have found no errors in the mathematics. Yet I am not entirely happy, satisfied. I should like to have found at least one example worked out in detail—one set of nk scores for n individuals on k tests worked through to the determination of the n values $g_x, g_y, \ldots$ of the general intelligences of those individuals and of the nk values $s'_{ax}, s'_{ay}, \ldots; s'_{bx}, s'_{by}, \ldots; \ldots$ of their special abilities on each of the tests. Theorems which prove the existence of some possibility do not satisfy the practical applied mathematician—we do not so much want to know that there is a solution to the problem as to know what the solution is! I will work an example below.

What solution does the author offer us? (First he adopts scales which reduce the scores on each test so that they have the same dispersion about their means, we may take it as unity, which is also the dispersion of g.) If r_{ag} be the correlation coefficient between g and the test a, he shows that the solution is

$$g_x = r_{ag} m_{ax}$$

with a probable error of $.6745\ (1-r^2_{ag})^{\frac{1}{2}}$. Note that the answer is a regression equation. We do not know the individual values $g_x, g_y, \ldots$; we could write

$$g_x = r_{ag} m_{ax} + e_{ax}$$
$$g_y = r_{ag} m_{ay} + e_{ay}$$

where $e^2_{ax} + e^2_{ay} + \ldots = n(1-r^2_{ag})$. If the author desires to prove that testing does not determine the general intelligence of the persons tested he has succeeded. Why did he pick on test *a* to determine g? Evidently one could equally well write

$$g_x = r_{bg} m_{bx}, \text{ etc.}$$

with a probable error $.6745\ (1-r^2_{bg})^{\frac{1}{2}}$, etc. Practically we might choose that test as *a* which has the highest correlation with g. Better, he shows how to weight the different tests so as to get a combined score *t* which best determines g. In the example this best score gives $r_{tg} = .75$ so that the probable error in g_x is $.6745 \times .6614 = .446$. When we recall that the scale of g is such that the standard deviation of g is unity or that one half of the n values of g lie between $-.67$ and $+.67$, two thirds of them between -1.0 and $+1.0$, we can appreciate the significance of a probable error of .45. The solution for the special ability is likewise

$$s_{ax} = (1-r^2_{ag})^{\frac{1}{2}} m_{ax}$$

with the probable error $.6745\, r_{ag}$. The better the test *a* estimates g the worse it estimates the special ability. Spearman's comment is: "We are faced by the fact that the current measurements of specific abilities—upon which have come to hang the weal or woe of countless individuals in industry and otherwise—are little more than the blind leading the blind." Rather pessimistic I call it, possibly unjustifiably so in view of such success as persons like O'Connor (West Lynn Works, General Electric Company) have in their placement work.

Spearman gives a long discussion of the attempts that have been made to define general intelligence. He does not define it, he computes it, and at that only by a regression equation, he does not measure it any more than he would weigh a person by computing his weight from his height through a regression equation of weight on height. He sets forth a hypothesis that the general intelligence is energy, the special abilities are engines, with apparently the will as engineer. This is allegory. If intelligence were energy it should be measured in ergs—but again he calls it a force (p. 414), so perhaps he thinks of measuring it in dynes. Or perchance the whole is mere logomachy. It would be interesting to enquire which of the technical physical terms is most like g, the general intelligence. Perhaps it might be efficiency! It would also be interesting to know just what he or Maxwell Garnett (a competent applied mathematician) means by the word unique in the proof that the resolution into g's and s's is unique. He can hardly mean that the regression equation $g_x : \sigma_g = r_{ag} m_{ax} : \sigma_a$ is unique since there is one such for each test and they give different results. If he means that given the nk grades $m_{ax}, m_{bx}, \ldots, m_{ay} \ldots$ we can determine the actual values of $g_x, g_y, \ldots$, why are we given the regression?

Example (*preamble*). If we can assign the k quantities $c_a, c_b, \ldots$ and the n values $g_x, g_y, \ldots$ equations (1) will determine the nk special abilities s′ from the nk grades m. Equations (2) if the n values $g_x, g_y, \ldots$ are known will determine the k values $c_a, c_b, \ldots$ as $c_a = \sigma_a r_{ag}/\sigma_g$. To have the intelligence g on a uniform scale we shall assume $\sigma_g = 1$ which gives one quadratic equation between the n values $g_x, g_y, \ldots$

$$g^2_x + g^2_y + g^2_z + \ldots + g^2_n = n \qquad (4)$$

We must find the k coefficients r_{ag}. Equations (3) when expressed in terms of the m's and g's give the equations

$$r_{ag} r_{bg} = r_{ab}, \qquad r_{ag} r_{cg} = r_{ac} \qquad (3)$$

and if there be three or more tests enable us to solve for r_{ag}, etc., as

$$r_{ag} = \sqrt{\frac{r_{ab} r_{ac}}{r_{bc}}} \text{ etc.} \qquad (5)$$

This requires that the values r_{ag} should be fractional or (if all the correlations r_{ab}, r_{ac}, r_{bc}, . . . between tests be positive, as is usually the case) that

$$r_{bc} \lessgtr r_{ab}r_{ac} \qquad (6)$$

or that the partial coefficients $r_{bc.a}$ shall all be positive, and, if there are more than three tests, that the so-called tetrad relations vanish, *i.e.*,

$$r_{ac}r_{bd} - r_{ad}r_{bc} = 0. \qquad (7)$$

These relations (6) and (7) are verified within the experimental error with respect to a large variety of intelligence tests. There is the equation

$$g_x + g_y + g_z \ldots + g_n = 0 \qquad (8)$$

introduced to simplify the analysis and refer all g's to their mean. If the m's are also thus expressed, as is most convenient, the s's will be relative to their means. The k equations (5) are linear in the g's, *viz.*,

$$m_{ax}g_x + \ldots + m_{an}g_n = n\, r_{ag}\sigma_a \qquad (5')$$

We have, therefore, in (5'), (8) and (4) the number $k+1$ of linear equations and one quadratic equation in the n quantities g. It would seem as though the n values g could be found with $n-k-2$ degrees of freedom, *i.e.*, that, as n is generally much larger than $k+2$, the solution should be indeterminate rather than unique.

Example (solution). Try a case. Let the marks of 6 students on 3 tests be (the first columns give the actual marks, the second columns give the differences from the means)

	a		b		c	
1	10	5	8	3	1	2
2	8	3	5	0	9	4
3	6	1	9	4	4	−1
4	4	−1	7	2	8	3
5	2	−3	0	−5	1	−4
6	0	−5	1	−4	1	−4
$6\sigma^2$		70		70		62

$$r_{bc} = .66,\ r_{ac} = .73\ \ r_{ab} = .74$$

The equations to be solved are

$$5g_1 + 3g_2 + g_3 - g_4 - 3g_5 - 5g_6 = 18.5$$
$$3g_1 + 0g_2 + 4g_3 + 2g_4 - 5g_5 - 4g_6 = 16.7$$
$$2g_1 + 4g_2 - g_3 + 3g_4 - 4g_5 - 4g_6 = 16.3$$
$$g_1 + g_2 + g_3 + g_4 + g_5 + g_6 = 0$$
$$g^2_1 + g^2_2 + g^2_3 + g^2_4 + g^2_5 + g^2_6 = 6$$

The result of solving the first four for g_1, g_2, g_5, g_6 in terms of g_3 and g_4 and substituting in the last is

$$g_3 = .49 - .7g_4 \pm .89_4 \sqrt{(-g^2_4 + .40g_4 + .069)}$$

The radical is positive only if g_4 lies between −.14 and +.52 and any value of g_4 between these limits is possible. For the two limits the solutions for the g's are

			diff.
$g_1 =$	.91	$g_1 =$ 1.43	−.5
$g_2 =$	1.21	$g_2 =$ .42	+.8
$g_3 =$	.59	$g_3 =$ .12	+.5
$g_4 =$	−.14	$g_4 =$ .52	−.7
$g_5 =$	−1.47	$g_5 =$ −.80	−.7
$g_6 =$	−1.10	$g_6 =$ −1.69	+.6

Notice that the ranges of possible intelligence for the six are different; we have a better line on 1 and 3 than on 6 and know least about 2.

Let us next compute the special abilities so standardized that their standard deviations are unity. The equations given by Spearman are like

$$m_{a1}/\sigma_a = r_{ag}g_1 + \sqrt{1 - r^2_{ag}}\, s_{a1}$$
$$m_{a1}/3.4 = .905\, g_1 + .42\, s_{a1}$$
$$s_{a1} = .7\, m_{a1} - 2.1\, g_1$$

On the basis of the extreme alternative solutions given above we have

			diff.
$s_{a1} =$	1.6	$s_{a1} =$ .4	+1.2
$s_{a2} =$	−.4	$s_{a2} =$ 1.2	−1.6
$s_{a3} =$	−.5	$s_{a3} =$ .5	−1.0
$s_{a4} =$	−.4	$s_{a4} =$ −1.8	+1.4
$s_{a5} =$	+1.0	$s_{a5} =$ −.4	+1.4
$s_{a6} =$	−1.2	$s_{a6} =$ +.1	−1.3

Similarly we could compute for tests *b* and *c* the limits of specific ability. (The calculations given above have been carried to so few places that a positive check can not be expected, either for the zero mean or the unit standard deviation.) What we have shown is that the complete solution can be obtained but is indeterminate. We have had no need of any harder mathematics than the solution of a set of $k+1$ linear equations and 1 quadratic equation. We do not need the generalized Bravais distribution (as used by Garnett) and in view of Yule's wise comments on mental measurements (*Brit. J. Psych.*, vol. 12, p. 100.) to all of which I hereby subscribe, it would seem quite superfluous to introduce this higher mathematics, involving a probability theory which probably does not apply anyhow, to make determinate (if it does) that which without it seems indeterminate.

Do g_x, g_y, . . . whether determined or undeterminable represent the intelligence of x, y, . . .? The author advances a deal of argument and of statistics to show that they do. This is for psychologists, not for me, to assess. I believe he does not adequately emphasize the fact that they represent the intelli-

ence only relative to the set-up of the tests. That his is so is evident from general considerations of the ransformation theory of correlation algebra; but as ven the term "transformation theory of correlation lgebra" seemed unknown and unintelligible to a rge group of persons professionally interested in tatistics and in education when I recently mentioned to them, I take the space, in a review already too ong, to expound the obvious. 1°, If we have nk marks of n individuals x, y, z, . . . on k tests *a*, *b*, *c*, . . . we may combine these marks into new sets of scores, call them *a'*, *b'*, *c'*, . . . , in a linear fashion as

$$m'_{ax} = c_{11}\, m_{ax} + c_{12} m_{bx} + \ldots$$
$$m'_{ay} = c_{11}\, m_{ay} + c_{12} m_{by} + \ldots$$

$$m'_{bx} = c_{21}\, m_{ax} + c_{22} m_{by} + \ldots$$

$$m'_{cx} = c_{31}\, m_{ax} + c_{32} m_{by} + \ldots$$

with k^2 constants c_{ij}. These new scores m' contain all the information of the old scores because they can be solved for the old scores m, but the information is differently assembled. It may be that these scores do not measure any particular ability such as spelling or literary interpretation or mathematical judgment, but they do represent scores involving certain weighted combinations of such abilities and with my limited knowledge of intelligence testing seem to represent some sorts of ability. 2°, Irrespective of whether the tetrad relations (7) are fulfilled, we can choose the constants c_{ij} in infinitely many ways so that the new scores are all uncorrelated, *i.e.*, $r'_{ab} = r'_{ac} = r'_{bc} = \ldots = 0$. In this case the tetrad equations for the new correlation coefficients must vanish. Now if $g_x, g_y, \ldots$ be the general intelligence of the persons tested the equations (3') can no longer be solved as in (5) for $r'_{ag}, r'_{bg}, \ldots$ because (5) become indeterminate; but inspection of the equations

$$r'_{ag}\, r'_{ag} = r_{ab} = 0$$
$$r'_{ag}\, r'_{cg} = r_{ac} = 0$$

shows that all of the correlations of g to the new scores must vanish except at most one. Which one? As the equations defining *a'*, *b'*, *c'*, . . . are largely arbitrary, the symmetrical and natural conclusion would be that none of them are correlated with g. Or we might so form one of them say *a'* as to agree that it represents the intelligence g with $r'_{ag} = 1$ and the others represent special abilities independent of g. Next, 3°, to be more specific we may take as one simple definition of *a'*, *b'*, *c'*, . . .

$$m'_{ax} = m_{ax}$$
$$m'_{bx} = m_{bx} - \sigma_b r_{ab} m_{ax}/\sigma_a$$
$$m'_{cx} = m_{cx} + \beta m_{bx} + \alpha m_a$$

and determine β, α, so that $r'_{ac} = 0$, $r'_{bc} = 0$, and so on. Now as we know r_{ag} by (5) as other than 0, it follows that $r'_{ag} = r_{ag} \neq 0$ and that the remaining values r'_{bg}, r'_{cg}, . . . all vanish. But from the definition of *b'*

$$0 = \sigma'_b\, r'_{bg} = \sigma_b (r_{bg} - r_{ab} r_{ag})$$

or

$$r_{bg} - r_{ab} r_{ag} = 0$$

This last equation is, however, impossible since we know that $r_{ag} r_{bg} = r_{ab}$. Hence, 4°, any set of values $g_x, g_y, \ldots$ for the general intelligence of x, y, . . . which will go with the set-up of tests *a*, *b*, *c*, . . . can not possibly go with the set-up *a'*, *b'*, *c'*, . . . but must be replaced by new values $g'_x, g'_y, \ldots$ approximate to that set-up. Yet the information we had in the nk scores of x, y, . . . on *a*, *b*, . . . is all contained in the nk scores assigned to x, y, . . . on *a'*, *b'*, . . .; the persons x, y, . . . are the same but their intelligences have changed—the old values whether indeterminate or unique will no longer do. What does this leave of the concept of the intelligence of an individual x as measured by g_x? Apparently only that it is relative to the set-up, which is the obvious proposition that I set out to prove.

The intelligence tester may object that the scores on *a'*, *b'* . . . mean nothing, are mere artificialities, whereas those on *a*, *b*, . . . are real things and mean something. I would not deny the objection. Although hypothetical unrealities may illuminate the significance of realities, it is the realities that make science. All I was trying to do was to supplement Spearman's discussion of the universality of g with a little contribution on the relativity of g—as might be expected of an erstwhile physicist! It seems to be an undeniable statistical fact that batteries of intelligence tests as given and as scored tend to be what has been termed hierarchical in that they tend to satisfy the tetrad relations (7). This fact means something, it needs to be explained, Spearman has offered an explanation. Possibly the explanation should have laid more emphasis on the tests and less on the general intelligence —I do not know—but in Spearman's system we have a method of examining our data, of discussing its implications, of organizing it into a philosophical system, just as we have in Einstein's, and at least for the immediate future the system propounded in "The Abilities of Man" can not be ignored by those working in its field. That is why I said that the Grote professor of philosophy of mind at the University of London has written an important book. Moreover, it is clearly, spiritedly. suggestively, in places even provocatively, written; intelligible and entertaining even to the general reader. The mathematics has been put out of the way in a highly compressed appendix. I have

chosen to take the risk of misrepresenting the character of the book by writing a very lop-sided review with its emphasis chiefly on the appendix because I know that this has offered difficulties to some very intelligent readers, because it appears logically fundamental to the whole system, and because some of its important logical implications seem not to have been expressed by the author in the main text.

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SPECIAL ARTICLES

TELESCOPIC OBSERVATION OF CATHODE AND ANODE POINTS

1. *Bright and dark sparks.* While the behavior of the anode in case of a mucronate electrode has been summarized,[1] further consideration of the cathode point is desirable. In this case the needle is to be critically set, so that the convection current is just about to pass into the spark condition. The set may often be made more sensitive, by waiting for some time until a convection current incidentally strikes and this may often be hastened by drawing sparks out of the cathode with a metal bridging the spark gap.

Since the U-tube interferometer is rather cumbersome for general observation, it may often be replaced by a suitable ear trumpet listening for the frequency of the crackle of sparks; or still better by a short range telescope (objective 6 or 8 inches off) focussed on the cathode point. Whenever the convection current passes, a bright oval cathode glow is seen in the telescope like the nucleus of a comet, while in the dark even the convection current itself may be seen looking much like a cometary tail. As soon as any spark transfer takes place, this oval glow is extinguished.

The spark successions which follow the extinction of the cathode glow are not, however, of the same kind. There are two distinct types, bright and dark. The first consists of diffuse bright purple spark filaments, passing with marked crackling between many favorable points of the electrode plates, the needle point being ignored. Being relatively luminous, they are the most desirable, but they often refuse to appear or are not sustained.

The second type which I shall have to call by a misnomer dark sparks, show no spark lines at all, but consist of a faint violet surface glow at the edges of the anode plate. The cathode glow is none the less extinguished. They are apt to be the more usual (and undesirable) occurrence, particularly after long observation. There is no appreciable crackling heard in the ear trumpet. I have therefore (without certain evidence) regarded the bright sparks, since they nearly always appear when the cathode is earthed, as resulting from a promiscuous issue of positive electrons from preferred parts of anode plate (since it here has no needle point), whereas the so-called dark sparks may be the corresponding convection discharge of positive ions from such parts of the anode plate.

2. *Negatively charged body.* The most available instrument for extinguishing the cathode glow is the charged hard rubber rod. If this is highly charged and the critical set sensitive, the rod may be passed normally along the arc of a vertical circle even 50 cm in radius around the spark gap, from right to left, always keeping the glow dark (Fig. 1). As soon as the rod passes outside of the circle by a few centimeters, the glow at once relights. This may be repeated indefinitely. A brass ball, 8–10 cm in diameter on an insulated handle and charged at the cathode of the machine is also convenient, though it acts from a smaller radius (15 cm) from the spark gap. A proof plane is still weaker. Now if the negative rod at a radius of 50 cm (say) evokes a shower of bright sparks persistently, then it usually happens that at a smaller radius of say 20 cm these bright sparks disappear, to reappear at the radius of 50 cm again. This was at first a very puzzling observation; but as the cathode glow is kept extinguished, it is a passage of the bright type of spark into the dark equivalent

[1] *Proceedings National Academy of Sciences*, February, 1928.

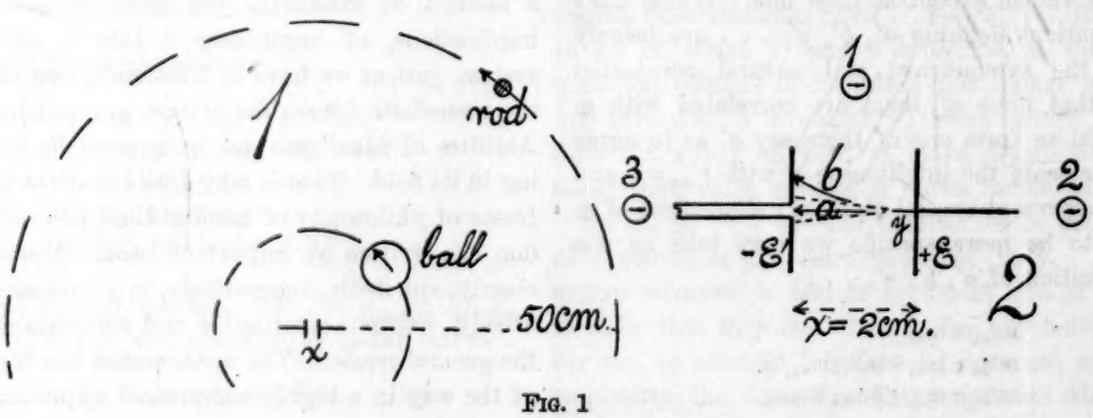

Fig. 1

ust described. Since it requires a greater protrusion, , of positive needle ($y > .3$ cm) to evoke the anode onvection current than the anode spark succession $y = .10$ to .14 cm for darts, $y > .14$ cm for cones), he above inference for bright and dark sparks is not nreasonable. The impression is often made as if the egative glow were transferred to the edge of the posiive plate and became a positive surface glow.

Finally, since the negative body acts to extinguish he cathode glow from a definite radius, one may rgue, as I have heretofore, that it imposes an efective negative increment of potential throughout the ield of the spark gap.

3. *Telescopic anode reactions.* To obtain darts (snapping white linear sparks) from the cathode point n the absence of the anode needle has not been posible. They appear at the anode point (cathode point absent) as an integration of the earlier diffuse spark ilaments for the narrow ranges of protrusion y, given, nless there is special stimulation (earthing the cathode, for instance) when darts appear sooner. The positive convection current does not appear until $y = .3$ cm or later, when a mere point of light tips the anode in the dark spark gap. Between these limits the dart degenerates into a purplish diffuse cone with its apex at the anode needle (see fig. 2). In the telescope the divergence is filamentary and scattering. As y ($< .3$ cm) increases, the cone grows narrower and weaker, and in the ear trumpet the crackling runs up into high frequencies. The spark gap is now in a good form for experiment. If, for instance, the negative rod[2] is put in the symmetrical position (1), figure 2, the straight symmetrical axis a of the cone changes to an axis b concave towards the rod, and more so as the rod is nearer. This proves adequately that the emitted rays, a, are positive ions and the method may be useful for measurement. Again let y be further increased until the luminous cone just vanishes and the dark convection current appears. Then it will be found that the negative rod at (2) on the anode side restores the cone a and keeps it; whereas the negative rod at (3) on the cathode side quenches the cone. The test may be repeated indefinitely. The negative rod at (2) or (3) is thus equivalent to a decrement or increment, respectively, of the protrusion y.

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[2] The magnetic field arising from a metal conductor is not convenient. The anode is much more capricious than the cathode. The convection current may strike too soon, or too late, or again not at all. The above data are good averages for the given machine and spark gap. Some control is possible, however, by the methods of § 3. The axial flexure of fig. 2 can not be obtained with the negative convection current.

FACTOR H IN THE NUTRITION OF TROUT

SINCE the time of Magendie, investigators have tried to develop purified rations which would meet all the requirements of the animal body for growth and reproduction. The greatest success in these attempts has undoubtedly been attained with the rat. That even the rat fails to show an optimum growth upon a simplified ration containing all the known elements, is evident from many experiments and especially from the recent reports of Osborne and Mendel,[1] and Palmer and Kennedy.[2]

The fact that many of the discoveries in nutrition that have been made in rearing rats have found ready applications in feeding the higher animals has led to the subtle assumption that the nutritional requirements of all species of animal life are the same. The reflection of such natural philosophy is seen in the wide-spread use of cod liver oil, yeast and other vitamin supplements in the hatcheries of the United States that are engaged in rearing trout. Although Laufberger[3] has stated that fish require vitamins in their food, his work fails to furnish convincing evidence that these are related to any of the known accessory substances required by the higher animals.

In order to furnish a more rational basis for feeding trout we have conducted a series of experiments upon their growth curves when they are fed diets of widely different compositions. These experiments have been performed at the Burlington hatchery in the state of Connecticut. This hatchery is unusually well equipped for such experiments, since it has a constant supply of pure spring water which exhibits very slight temperature variations. Each experimental group of trout contained fifty fingerlings which were confined in separate troughs with individual water supplies and outlets. The efficacy of a given diet was judged by the average growth rate and by the mortality rate.

In our first series of ten experiments we employed nine purified rations made up of casein, boiled starch, salt mixture, cod liver oil and yeast. In four of these the protein was incorporated at various levels from ten to seventy-five per cent. In two, lard was included at twenty-two and fifty-seven per cent. levels varying the other factors to secure adequate salt and protein intake. From one, cod liver oil was omitted; in another yeast was lacking and still another contained no salt mixture. For purposes of comparison a diet of dried skimmed milk was employed. For seven weeks all the fingerlings, except those upon the

[1] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1926, LXIX, 661.

[2] Palmer, L. S., and Kennedy, C., *J. Biol. Chem.*, 1927, LXXV, 619.

[3] Laufberger, V., *Physiol. Abstracts*, 1926, XI, 221.

ten per cent. protein diet, grew normally practically doubling their weight. Those upon the lowest protein level refused to grow but ate their ration readily and remained active.

At the end of seven weeks all groups commenced to die except those upon the low protein diet and those upon the dried skimmed milk. The latter continued to grow until at the end of sixteen weeks they averaged five times their initial weight. At this time they ceased to grow and began to die. The entire fifty had died at the end of the twentieth week.

At the end of the fourteenth week those upon the low protein diet began to die. This continued at a regular rate until the twentieth week when only seventeen remained alive. They were now divided into two groups. One of these received raw liver and the other remained upon the purified ration with the low protein level. Those fed raw liver immediately assumed an optimum growth rate and in nine weeks tripled their weight. Those kept upon the low protein diet did not grow and all died in the course of the next five weeks.

From these experiments we must conclude that raw meat contains some factors which is neither vitamin A, B or D and which is an unrecognized dietary factor essential for the growth of trout. Dried skimmed milk contains a small amount of this factor but not enough to permit continued growth for long periods, Furthermore trout require a diet containing more than ten per cent. protein for normal growth. In case they are stunted by a protein deficiency the power or resuming growth is not lost even at the end of five months. In the course of these experiments it was observed that trout which are stunted by protein deficiency do not develop the spots commonly observed upon this species of eastern brook trout while those that are allowed to grow develop these spots quite normally. The development of these is a function of growth and not of age.

In a second series of experiments twenty different rations were employed. One of these was a purified feedstuff of casein, starch, salt mixture, cod liver oil and yeast modeled after those previously used and commonly employed in work upon rats. This was accompanied by a ration of the same composition except that it contained orange juice. The trout showed a reaction that duplicated our previous experience. They displayed a slight initial growth followed by failure. Hence we must conclude that the unknown factor H which is found in raw meat is not vitamin C.

In this second group of experiments attempts were made to determine if this factor were sensitive to heat like that described by Dr. Wulzen[4] in her studies upon planaria. Comparative studies were made between raw liver and that which had been cooked and dried for other experiments upon blood regeneration by the senior author.[5] Dried liver gave no response while fresh liver gave the usual excellent growth. From this, one must conclude that the factor in liver responsible for growth in trout is destroyed by heat. Furthermore it is an entirely different factor than that responsible for blood formation since the same cooked, dried liver produces excellent blood regeneration in rats, but fails to promote growth in trout. We have studied two commercial dried meats and find both of them entirely lacking in this growth stimulating power.

Two other diets which have been studied may be worthy of record. We have fed trout Sherman's stock ration for rats which consists of whole wheat, dried whole milk, calcium carbonate and sodium chloride. Trout consume this ration readily, but do not grow. From this we may infer that factor H is not related to vitamin E.

In order to determine whether the growth secured upon dried skimmed milk was the result of its composition or some extra factor which it contained, we prepared a synthetic product of casein, lactose and salt mixture and fed this supplemented with cod liver oil and yeast. Only slight growth resulted from this ration and the trout began to die at the end of the fifth week. This experiment is being repeated with part of the protein furnished by lactalbumin. We must conclude that natural dried skimmed milk contains factor H and "synthetic milk" lacks it.

Both the yeast and the cod liver oil employed in these experiments were products of tested potency.

The discovery of factor H to which we have called attention must be credited to those pioneers in the rearing and propagation of fish who long before our generation found that trout required raw meat for proper growth and would fail upon the dried products.

This work has been made possible through the Connecticut Board of Fisheries and Game and their representatives Mr. Titcomb and Mr. Cobb. We also wish to thank Professor L. B. Mendel, of Yale, and L. A. Maynard, of Cornell, for useful suggestions in the course of these experiments.

The complete data with growth curves will appear in the *Transactions* of the American Fisheries Society for 1927.

C. M. McCAY
F. C. BING
W. E. DILLEY

CORNELL UNIVERSITY

[4] Wulzen, R., SCIENCE, 1927, LXV, 331.
[5] McCay, C. M., *Am. J. Physiol.*, 1928, LXXIV, 16.

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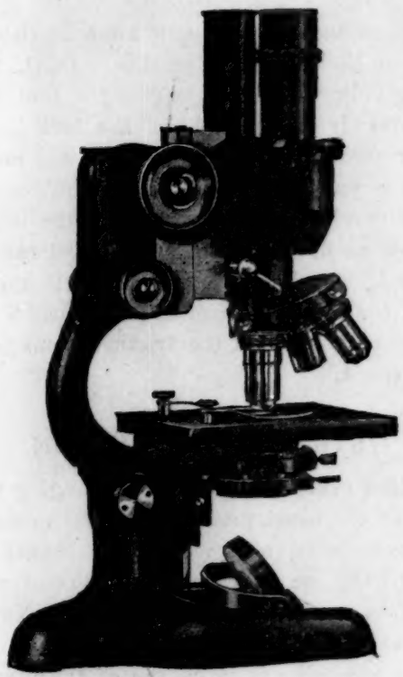

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SCIENCE NEWS

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SOME PAPERS PRESENTED BEFORE THE NEW YORK MEETING OF THE AMERICAN PHYSICAL SOCIETY

AT the meeting of the American Physical Society, in New York, which opened on February 24, Dr. Ernest O. Lawrence and Dr. J. W. Beams, of Yale University, told of their studies of the length of time required for this "photoelectric effect." Less than a three billionth of a second is all the time that it takes an electron to be knocked out of a film of potassium metal when light strikes it in a photoelectric cell—the device that has made television and radio photographs possible. In the photoelectric cell there is a film of potassium, and another electrode. When light strikes the film the electrons travelling from the film to the other electrode cause a minute electric current, which can be amplified by means of vacuum tubes. In this way a current of any desired magnitude, but one which varies with the illumination of the cell, can be obtained. Because the response of the cell is practically instantaneous, it can be used in television and wire and radio photographic service.

MEMBERS were able to see by wire through walls and around corners when they were given a special demonstration of the process of television developed by the Bell Telephone Laboratories. This was the process that was used last April in the first successful long-distance television tests, when Secretary Hoover spoke in Washington and was seen in New York. At a session of the society at the Bell Laboratories, Dr. Herbert E. Ives, under whose direction the method was developed, explained its operation, and the recent improvements that have been made on it.

STUDY of such devices as radio loud-speakers on the basis of the sound waves that come to the listener's ear is now possible with an instrument invented by Dr. Dayton C. Miller, of Case School of Applied Science, Cleveland. Dr. Miller described this new use of his apparatus, which he calls the "phonodeik." He made the experiments in conjunction with John R. Martin. The phonodeik makes a photographic record of the sound wave as it is received by the ear. Dr. Miller's method is to connect the loud-speaker undergoing test to a microphone, then to record the output on the phonodeik. A similar record can be made of the original sound, and by comparing the two, the characteristics of the speaker determined. When a vacuum tube voltmeter is substituted for the speaker, the experimenter can determine how much distortion is introduced by the electrical system, and make allowances for it.

NECKTIE and clothing manufacturers probably still have plenty of colors left with which to add to the brilliance of life. Altogether there are slightly over two million separately distinguishable colors possible. This is the conclusion by George B. Welch, of Cornell University, who spoke before the society.

BOWLING enthusiasts will now have available a scientific study of their favorite pastime. Dr. L. W. Taylor, of Oberlin College, told of apparatus that he has developed to study the motion of the ball in a bowling alley. A recording device registers to the hundredth of a second the passage of the ball at half-meter (about 20-inch) intervals. Instead of rolling the ball by hand, a catapult is used, so that the force used can accurately be controlled. Studies already made with the device indicate that the accepted theories of the ball's motion are not quite correct, but that the friction seems to vary with the ball's speed.

STELLAR EVOLUTION

A STAR that exploded, and is now changing to a nebula, in reverse of the usual process of stellar evolution, is the rare spectacle being observed at the branch station of the Harvard College Observatory at Bloemfontein, South Africa. This unconventional behavior of Nova Pictoris, as the star is called, was discovered by Dr. J. S. Paraskevopoulos, who is in charge of the branch station, Dr. Harlow Shapley, director of the observatory, announced through Science Service. Confirmation of the discovery has just been received from the Observatory of LaPlata, in Argentina.

Until the spring of 1925 this star was too faint to be seen with the unaided eye. Then it suddenly flared up as a nova, or "new star," and was discovered by R. Watson, a South African amateur astronomer. The star is in the constellation Pictor, the painter, a group not visible from northern latitudes.

"The evolution of stars," Dr. Shapley explained, "is generally thought to be in the direction from nebula to star, but in this instance, and in two or three others, the transformation is in the opposite direction, and astronomically speaking, is very rapid. All of these reversed cases are associated with the so-called novae, or new stars.

"Examination of earlier plates in the great collection at the Harvard Observatory, in Cambridge, where the southern photographs are stored, showed that before its outburst, it had been of the twelfth magnitude, and astronomers believe that it will gradually return to that same degree of faintness.

"Dr. Paraskevopoulos' discovery was based on photographs of the star, made under various conditions, with the rapid photographic telescopes which he has recently transferred from the former Harvard station in Peru to the new site in South Africa. A ring or shell of nebulous matter appeared around the outer edge of the image of the star, and has gradually grown larger and more dis-

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tinct. The phenomenon clearly indicates that the outburst of the nova, and its rapid increase three years ago to ten thousand times its former brightness, was actually an explosion of the star, which blew its outer parts away from the nucleus.

"The ring of nebulosity now observed is the former outer portion receding with a velocity of several hundred miles a second. Future observations will show whether the explosive transformation will result in one of the permanent typical 'planetary' nebulae of which a hundred or so are known among the stars, or whether the receding atmospheres will gradually dissipate into space, leaving the nucleus as a typical star.

"The normal course of stellar evolution," Dr. Shapley stated, "is believed to be in the direction of contraction, and for perceptible progress requires billions of years; but these suddenly expansive transformations are in the reverse sense, require but a few years, and may be exceedingly important in knowledge of the development of celestial bodies."

The observation from the University of LaPlata, which confirmed the Harvard astronomer's detection of the expanding gaseous shell around Nova Pictoris, was made by Professor Hartmann, director of the National Observatory of Argentina. His observations were made visually with a large refracting telescope. He cabled that the angular diameter of the ring is now one second of arc. Dr. Paraskevopoulos' description of his observations is being published by the Harvard College Observatory.

MOUNT LASSEN

MT. LASSEN, America's principal active volcano, is still asleep, but the spectacular effect produced by blowing clouds of snow, mixing with the steam that the crater is continually emitting, may give the illusion of a return to activity. The effect is especially striking when it occurs near sunrise or sunset, according to R. H. Finch, associate volcanologist of the U. S. Geological Survey, whose work it is to keep his finger on the pulse of the slumbering volcano. That it is merely slumbering, and not dead, is indicated not only by the steam, but by frequent earthquakes. Sometimes several shocks occur on the same day.

Evidence of subterranean activity also comes from Glass Mountain, about seventy-five miles north of Lassen Peak, and in the Modoc lava beds. Fairly recent lava flows are to be found nearly all the way between Glass Mountain and Lassen Peak, and Forest Service officials in the vicinity report about half an acre of land covered with pumice which is very hot. By digging but a little way into the pumice much higher temperatures are reached, and near the pumice bed is a deep fissure emitting steam.

With George L. Collins, of the National Park Service, Mr. Finch attempted to make temperature measurements and to take photographs on the mountain, about 7,850 feet high, during January, but were driven back by a heavy snow storm. They are now planning to conduct further explorations in the spring.

According to the Indians the heat of Glass Mountain has been known for many years, and earthquakes originating in the mountain and accompanied by rattling noises have been noted by Forest Service officials for at least fifteen years.

MAN-MADE EARTHQUAKES

MAN-MADE earthquakes, recorded some distance away upon a simple form of seismograph weighing only a few pounds, are helping Russian engineers to survey the site of the proposed Turkestan-Siberian railroad.

The method is to detonate charges of explosives underground and to record the travel of vibrations through the ground in different directions. By a minute study of the records so obtained it is possible to secure data on the geological formation of the locality.

The new seismograph invented by Professor Paul M. Nikiforov, director of the Physico-Mathematical Institute of the Russian Academy of Science at Leningrad, is similar to one recently invented in the United States by Dr. John A. Anderson, of the Mt. Wilson Observatory in California. Its main part, the pendulum, is a small vertical cylinder of pure gold suspended a little off center on a pair of fine wires. Whenever there is any vibration the cylinder turns slightly in proportion to strength of the shock. A tiny mirror attached to the pendulum reflects a beam of light on a constantly advancing sheet of photographic paper. Every turn of the cylinder, no matter how small, shifts the light spot considerably and it traces a wavy black line. Several of the new instruments are now installed on earthquake stations in Turkestan and Crimea and give complete satisfaction.

THE DETECTION OF FLAWS IN CASTINGS

USING radium rays so penetrating that they can go through pieces of metal—15-inch pieces of metal—to test for hidden flaws in large castings is one of the latest accomplishments of the Russian State Radium Institute.

These "gamma rays," as they are called, are similar to X-rays, but are of much shorter wave-length. They are more penetrating and can pass through pieces of metal too thick to be examined with the X-rays. Examination by radium is said also to be cheaper than with X-rays, because the same radium can be used over and over for an indefinite time. Large and expensive photographic plates are not required, since the rays, after passing through the object, act upon a special, sensitive electroscope. The test record is preserved for future reference in the form of a simple diagram automatically traced. Another advantage is that the gamma rays speed up the inspection—it may be cut down to a couple of minutes for a large casting—while X-rays require a very long exposure, often of several hours, when metal is more than two or three inches thick.

The apparatus, as developed by the Russian scientists, is very simply constructed. A tiny glass capsule with a radium preparation is inserted into a deep hole bored in a large lead ingot. This stops all rays, except a narrow strong beam that goes along the bore. This beam pierces the casting and encounters two filaments charged with electricity and enclosed within a copper cage. There is an air space between the filaments and the cage which act normally a perfect insulator, allowing no electric cur-

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rent to pass through it. But as soon as gamma rays have a chance to get in the cage they ionize the air and turn it into a conductor.

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A NEW TYPE OF HEAVY LOCOMOTIVE

A NEW type of locomotive, the heaviest yet used in Europe, is being built in Germany. It is especially designed to haul heavy freight trains over tracks cursed with many curves, and through regions where water is scanty.

The Garrat locomotive, as the new engine is called, shows a radical departure from the usual types of locomotive design. The driving wheels, of which there are two sets of six each, are not placed under the main body of the locomotive at all, but under the tenders. Of these there are two, one of them pushed ahead of the engine and the other pulled behind in the usual position. The cylinders are as far apart as possible, the forward pair being under the forward end of the front tender, while the rear pair is under the opposite end of the rear tender. This necessitates long steam lines, but the builders claim that they are able to deliver steam at 189 pounds pressure with entire success.

This type of construction makes the locomotive a three-section affair, articulated by two pivots. Although total length is 75½ feet, it can turn in a circle of 300-foot radius.

The forward tender carries nothing but water, the rear one both water and fuel—either oil or coal. In addition, there is a third supply of water carried in a tank slung under the boiler, in the space usually occupied by the driving mechanism. In all about 27 tons of water can be carried, and about 15 tons of fuel. The unusual capacity for water is designed to permit the locomotive to operate in arid regions.

The total weight when ready for service is 206 tons.

ITEMS

A NEWLY-INVENTED German machine, designed to do for Occidental grain fields what Chinese coolie labor has done for centuries in the rice fields of the East, is attracting considerable attention on the part of British agriculturists. Instead of sowing seed like an ordinary grain drill, it sets out sprouted and rooted seedlings at the rate of 12,000 plants per hour, one to every square foot. It is claimed that this method of raising grain requires only one thirtieth as much seed as now used, and that it will yield from three to five times as many bushels to the acre. This is said to be the result of the greater freedom each plant has to develop a more vigorous root growth beneath the soil, and especially to tiller, or "stool out," above its base. From 30 to 40 stalks per plant are usually developed.

MEDIEVAL cathedral builders, if they could come back to life, would probably regard with superstitious awe the modern power-driven saws, drills and planes that speed up the shaping of the thousands of tons of stone used in the construction of Washington cathedral, now going up on Mount Saint Alban. Each of the 260,900 stones that the builders' estimates call for must be separately designed and shaped for its particular place. As soon as the architect determines the specific shape and dimension, each of the stones that weigh from 300 to 500 pounds apiece, is numbered. These numbers appear on all drawings, on the individual time cards, which record the progress of each stone through the cutting plant, on the completed stone and on the plan followed by the mason. The cost of the stones varies from $10 for the plain ones, used for the basic construction, of which 146,000 will be needed, according to the estimate, to $300 each for the 5,000 elaborately sculptured ones. In addition to this, thousands of molded and carved stones at $50 and $100 apiece will go into the complete structure.

NEW finds of fossil footprints in the rocks of the Grand Canyon of Arizona, but this time on the north rim, fourteen miles from the site of previous discoveries on the south rim, are reported by Dr. Charles W. Gilmore, of the U. S. National Museum, and Glenn E. Sturdevant, government naturalist of Grand Canyon National Park. Slabs bearing the foot imprints of small reptiles or salamander-like amphibians were found at two levels, one in the Coconino and one in the Supai formation. These correspond with two of the three formations on the other side of the canyon in which tracks have been found during the past few years, but further exploration and examination of specimens will have to be carried on before it can be determined whether the levels match up exactly and whether the tracks represent the same kinds of feet. The fossil footprints from the south side of the canyon thus far discovered represent 36 species, distributed among 28 genera.

EVIDENCE that stone age man lived in Ireland, hitherto lacking, is now supplied by J. P. T. Burchell, of London. Mr. Burchell has discovered a rock shelter typical of the Mousterian period, when Neanderthal man roamed Europe, on the Sligo coast, and beneath it and along the beach he has found large quantities of the roughly flaked flint implements which these ancient savages made. No bones have been turned up as yet, but the quantity of tools and weapons leaves no doubt that some one was in Ireland to make them. Like other sites of the same culture, this shelter was inhabited during an interlude between two advancements of the ice of the most recent glacial epoch. Evidence on this point is cited by Mr. Burchell in two forms: the layer in which the implements are found is buried under 35 feet of boulder-filled clay, such as glacial deposit; and one of the largest of the stone implements is scarred with glacial striae or scratches, indicating that it was caught under a glacier and scraped over other rocks. The finds have been examined by J. Reid Moir, one of the foremost of British authorities on the stone ages, who pronounces them authentic. A complete technical report will probably be published in the near future.